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# PROLONGED DISTURBANCES OF CONSCIOUSNESS FOLLOWING HEAD INJURY*

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THE majority of patients admitted to a general hospital with injuries to the head either die or regain consciousness within seventy-two hours after the accident.[1] In a small percentage of cases, however, a period of initial coma merges into one of disorientation or mental confusion, often called "traumatic delirium" or "traumatic stupor," that may last for days or even weeks. When the confusion is of long duration, anxiety concerning the possibility of a complication, such as extradural or subdural hemorrhage, is prolonged and there is often uncertainty regarding the future mental status of the patient. The relative significance of abnormal neurologic, psychiatric and medical findings is often difficult to assess, for there are usually disturbances in all three fields. The following analysis reviews the interrelation of these disorders, and attempts to determine the average course of the illness in a group of such patients examined. These patients are being followed in a wider statistical survey of head injuries by the staff of the Neurological Unit, Boston City Hospital.

## GENERAL CLINICAL ASPECTS OF TRAUMATIC MENTAL CONFUSION

Descriptions of acute traumatic psychoses have been given in the English literature by Meyer[2] and Schilder,[3] and more recently by Palmer[4] and Ebaugh and Brosin.[5] Symonds[6] has contributed a rigidly critical and complete analysis of the mental disorder characterizing traumatic confusion, based on 16 cases in closed head injury without evidence of localized brain damage. He believes that the confused mentation is representative of a severe degree of the disorientation that follows simple concussion. He found the same difficulties in the sphere of perception as were noted by Schilder, and considered that difficulties in the synthesis of perceptual data play a large part in causing the confusion. He believes that the rationale of *Gestalt* psychology as advanced by Goldstein[7] is useful in the understanding of errors arising from limitation of perception. Symonds noted the common persistence of residual defects in memory and judgment, but found no absolute correlation between the duration or degree of the traumatic psychosis and the severity of these aftereffects. He and Denny-Brown[8] cite cases in which the usual signs of cerebral contusion, laceration or subdural hematoma were lacking and the spinal fluid was clear and under normal pressure. Denny-Brown believes that the physical intracellular disorder of concussion can overlap other complications and is of primary importance in the genesis of persistent intellectual defect. He holds that in most cases the severity of injury has been such as to cause additional complications.

Whereas the material included in this paper does not pretend to solve this problem, the data presented are representative of the mixture of disturbances usually encountered. The majority of injured persons who had experienced only simple concussion regained full consciousness within a few minutes to hours. In most cases in which early fatality resulted from trauma to the head, the patients remained comatose or profoundly confused throughout their course. Intermediate between these two extremes and preceding the phase of prolonged confusion discussed herein was unresponsiveness except for withdrawal from pain, which sometimes persisted for hours or days, with or without gross neurologic abnormalities. The following clinical description based on the observations of these patients will serve to identify the general nature of the post-traumatic confusion state as observed by us.

In some types of cases the period of coma was followed by a quiescent state, with or without normal sleep. Other patients passed immediately into a stage of acute restlessness, with increased psychomotor activity and incoherent talkativeness (traumatic delirium). In this agitated condition, effort was poorly directed and sustained and movements sometimes appeared aimless. Inappropriate actions, such as the brushing away of bandages and the discarding of bedclothes, were the apparent responses to all stimuli the nature of which were not clearly

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apprehended. Realization of the significance of the situation and of their actions was obscured by the patients' clouded sensorium. While in this mental state, a few patients occasionally appeared to be performing their everyday occupations, making motions consistent with such activity and carrying on fragments of conversation with relatives or friends. The continuity of action was usually broken and the sequence of thought and speech was often disorganized, even when actual incoherence or dysphasia was absent. This fragmentation of mental expression slowly became reorganized into coherence as recovery supervened. Perseveration of thought and action, as well as distractibility, indicated the inefficiency of mental processes. Even after the patients responded clearly to questions and commands, loss of recent memory and disorientation regarding personal identity were sometimes present. Elderly patients often regressed in time and were concerned with the problems and events of their youth.

Drowsiness, alternating with overactivity or occurring alone, usually subsided gradually with the confusion, to be supplanted by a wakeful apathy in which there was no appreciable defect in perception or orientation. The patient was sometimes so completely devoid of interest that cataleptic phenomena were observed. Extreme apathy with speechlessness resulted in the clinical picture of stupor, sometimes to a degree resembling motor dysphasia.

Fright was seldom observed except in the patients with incipient delirium tremens. Bewilderment was more frequent. Hallucinations are said to be frequent and mainly of visual and tactile nature. Although it is true that such phenomena may be easily missed if the patient is not under constant observation, definitely recognizable hallucinatory experiences occurred only in the cases of head injury complicated by alcoholism, senility or cerebral arteriosclerosis. This was true also of confabulations, despite the importance accorded in the literature to the Korsakoff or amnesic-confabulatory syndrome. When this picture did develop, it was apt to be associated with euphoria. Hallucinations and confabulations are said to be rare in children and young adults, an impression that is consistent with the previous statements. Negativistic or passive uncooperative behavior occurred at all times but was frequent at night, when the level of awareness fluctuated. At such times when visual and auditory perception was poor, the environment was often subject to misinterpretation and regarded as threatening, with an appropriate affective response on the part of the patient.

In many cases, after the return of orientation with regard to person and place full appreciation of the situation was delayed for some time. It was during this period that the behavior of the patient was usually abnormal. Extreme irritability, with violent and profane rages, could be manifested on little provocation in well-preserved patients as well as in demented ones. In some patients a fatuous vacuity or euphoria made them oblivious of the serious consequences of their injuries. Emotional lability was often encountered, and affective responses tended to be limited to a single type, such as elation, depression or apathy. In the convalescent period, when orientation was normal and the emotions relatively stabilized, a residue in the form of general nervousness, increased irritability or other slight change of personality often persisted.

## Case Material

The material presented in this study consists of the data obtained from the various medical, neurologic, and psychologic examinations of 39 patients who presented disturbances of consciousness, such as coma, semicoma, confusion, delirium, stupor, drowsiness and dysphasia, lasting longer than seventy-two hours after injury to the head. These patients represent approximately 8 per cent of all cases with head trauma admitted to the Boston City Hospital during a six-month period. All the group were examined within two hours after their accidents. The duration of hospitalization varied from four to sixty-two days, with an average of twenty-nine days. After discharge, the patients were followed whenever possible at home or in the institutions to which they had been transferred.

There were 31 males and 8 females. Their ages ranged from six to seventy-two years, with a mean of thirty-nine years. Twenty patients (51 per cent) were in the fourth and fifth decades. The sex ratio and mean age of this selected series coincided with that found in the total number of admissions to this hospital for injury to the head during this period, an analysis of which has been presented elsewhere.[9] There was considerable evidence of social maladjustment before injury as revealed by the marital status, alcoholism, previous behavior and personality characteristics. Of the 21 patients who had been married, 14 were widowed, divorced or separated. Twenty-three patients (60 per cent) were alcoholic, and of this number only 2 of the 13 who had been married were still living with their spouses. Seven of the 10 unmarried alcoholic patients were over the age of thirty years, at which time the majority of people have married. Eight patients (20 per cent) had shown pre-existing evidence of mental and physical deterioration, usually on the basis of alcoholism, although in isolated cases epilepsy, morphine addiction, senility and hypertension were contributory factors. Ten patients (26 per cent) had constituted behavior problems to their families or to the community previous to the accident, and 3 were criminals with prison records. From the psychiatric viewpoint, 21 patients (54 per cent) could be classified as psychopathic personalities. Psychotic episodes had occurred in the pretraumatic histories of 2 patients.

The manner of injury to the head was in most cases remarkably similar. Eighteen patients (46 per cent) had fallen downstairs or on paved streets, a type of accident especially frequent among alcoholic patients. Full details concerning such accidents were rarely obtainable, since most of these patients were found lying on the sidewalk in a comatose condition. Traffic accidents were responsible for the next largest group (36 per cent), and a variety of incidents accounted for the remainder.

## Definition of Terms

The duration of the post-traumatic psychosis, with its intellectual, emotional and personality disturbances, may extend well into weeks or months and the end is often difficult to define. The period of disorientation can be more definitely delimited, and in these cases was ascertained by asking specific questions pertaining to time, place and situation, repeated at daily intervals. For the purposes of this study it was therefore found convenient to regard confusion as synonymous with disorientation in one or more spheres, and the data have been arranged according to the duration of such confusion. Coma and semicoma were considered ended when the patient was able to respond recognizably to calling by name.

In Table 1 the frequency of abnormal signs is listed. In Tables 2 and 3 a number of findings are analyzed with regard to their duration. Short, medium and long periods of confusion were arbitrarily chosen so that a similar number of cases in each group would be available for comparison. The separate listing of patients who died was dictated by the fact that death rather than recovery determined the end of the confusion, and only those patients who died after three days have been included. The temperature, pulse and respirations were considered to have returned to normal when fluctuations of these vital signs did not exceed the accepted norm[10]; in addition, the occurrence of abnormally high or low values was noted. Blalock's[11] definition of surgical shock was followed. Many minor abnormal findings were obtained on neurologic examination, but only Babinski's sign and inequalities or absence of tendon reflexes occurred with sufficient frequency to be tabulated. Focal or generalized disturbances of frequency in the electroencephalographic tracings were regarded as attributable to the head injury, in accordance with the criteria of studies reported in the literature.[12*]

Some of the terms used are self-explanatory, but others demand arbitrary definition. Acute alcoholism was recorded when the odor of alcohol on admission was substantiated by a history of considerable intake immediately before the accident. Habitual use of alcohol to excess, with frequent arrests for drunkenness or a history of delirium tremens, was considered evidence for alcoholism Apathy was defined as a state in which the patient shows no interest in his own condition, his physician or his surroundings. The period during which the patient could not respond to psychologic tests was measured by ability to co-operate in such simple tasks as serial subtraction or study of absurd pictures. Data regarding the manner in which the response to such psychologic tests is disturbed following head injury have been analyzed and presented elsewhere.[9, 13] The ability to co-operate in any degree in such tests is here recorded as a stage in the recovery process. Drowsiness was regarded as a condition in which the patient tends to fall asleep repeatedly during the ordinary waking hours. In hospital records such variable states as semicoma, confusion, apathy and lack of speech are often described as stupor. We have used this word to describe those patients who were able to eat or drink and maintain body position but failed to give any verbal responses. The term "incoherence" is used to describe the condition, irrespective of its etiology, in which speech was disorganized, reaching the extreme in a confused mixture of words. In this study the use of the term "perseveration" has been limited to repetition in speech. An abnormal sense of well-being has been described as "euphoria," and a morbid impulse to joke as "moria." Patients who had difficulty in adjusting to the hospital environment after they were sufficiently recovered to be ambulatory on the ward were considered behavior problems.

In evaluating the status during the immediate follow-up period, dementia was adjudged to be present when disorientation still existed after three months. In those patients designated as intellectually impaired, the psychometric findings were well below the range that could be expected from the school and occupational histories. Except where actual measurements such as those of pulse, temperature, respirations and spinal-fluid pressure could be used, only the presence or absence of certain features was noted, since the degree was a matter of interpretation.

## Clinical Data

### *Frequency of Signs*

The principal abnormal findings are presented in order of frequency in Table 1. Abnormal electroencephalographic findings (93 per cent), bloody spinal fluid (90 per cent) and elevated spinal-fluid pressure (74 per cent) occurred in the great majority of cases. Babinski's sign (67 per cent) and skull fracture (65 per cent) were next in frequency. This tabulation focuses attention on the high incidence of the presumptive evidences of severe brain damage in patients with prolonged confusion as a result of head injury.

Many compound or depressed skull fractures, together with the intracranial hemorrhages, ac-

*We are indebted to Dr. Charles Brenner for the electroencephalographic data.

counted for the large number of operations in this series. The frequency of subdural or extradural hemorrhage (27 per cent) indicates that these complications should be carefully considered in confused patients. During their early hospital course 15 per cent of the patients experienced convulsive seizures.

Intellectual disturbances, such as perseveration, confabulation and dysphasic disorders, outnumbered other mental abnormalities. Ten patients (26 per cent) presented behavior problems on the ward. Apathy and marked irritability were encountered in about a third of the cases. Hallucinations were relatively rare (14 per cent), and with the exception of 1 case occurred only in acute or chronic alcoholic patients.

TABLE 1. *Frequency of Abnormal Findings.*

| FINDING | FREQUENCY |
|---|---|
| | % |
| Abnormal electroencephalographic findings | 93 |
| Bloody spinal fluid | 90 |
| Pressure above 200 mm. of water on lumbar puncture | 74 |
| Babinski's sign | 67 |
| Skull fracture | 65 |
| Restlessness | 64 |
| Acute alcoholism | 60 |
| Respiratory rate above 30 | 51 |
| History of chronic alcoholism | 50 |
| Abnormalities of tendon reflexes | 49 |
| Perseveration | 48 |
| Maximal fluctuation of diastolic blood pressure above 40 | 47 |
| Pulse rate above 120 | 46 |
| Pulse rate below 60 | 41 |
| Confabulation | 39 |
| Maximal fluctuation of systolic blood pressure above 60 | 38 |
| Dysphasic disorder of speech or perception | 36 |
| Skull operation | 36 |
| Apathy | 33 |
| Temperature above 103°F. | 31 |
| Irritability | 28 |
| Subdural or extradural hemorrhage* | 27 |
| Behavior problem | 26 |
| Stupor | 23 |
| Complicating extracranial injuries | 20 |
| Incoherence of speech | 18 |
| Convulsions | 15 |
| Hallucinations | 14 |
| Surgical shock | 11 |
| Euphoria and moria | 10 |

*Verified by operation or autopsy.

It is worth noting that a great number of signs were comparatively infrequent in the patients in whom the duration of confusion was short (Table 2). Patients disoriented for less than twenty days did not have convulsions or incoherence, although the incidence (40 to 60 per cent) was fairly high in those confused for twenty-one days or over. Likewise, neither stupor nor a temperature above 103°F. was found in patients disoriented for less than ten days. In contrast to these findings, there were signs that were no less frequent in the patients in whom confusion was of short duration. Among these were abnormal electroencephalograms, Babinski's sign, significant respiratory, pulse and blood-pressure changes, complicating extracranial injuries and surgical shock. Apathy, euphoria and moria were actually more frequent in the patients who were disoriented for less than ten days than in others.

Acute and chronic alcoholism occurred in well over half the cases. The mean duration of confusion in the alcoholic group (nineteen days) was considerably longer than that in the nonalcoholic group (eleven days). It should be pointed out, however, that the mean age of the alcoholic patients was also greater than that of the other subjects (forty-six as compared with thirty-one years).

Not mentioned in the tables were the following features that occurred in relatively few cases. Eight patients (21 per cent) had a history of previous head injury. Three showed a lucid interval between an initial and later period of confusion, and 2 exhibited marked fluctuation in the level of consciousness. Four of these 5 patients were found to have subdural hematomas, and in the fifth the right frontal lobe had been traumatically amputated. The 3 patients with dementia exhibited an abnormally increased appetite.

The 5 patients who died during their initial hospitalization represented particularly severe head

TABLE 2. *Changes in Frequency of Findings With Decreasing Duration of Confusion.*

| DATA | ALL CASES | DEATH AFTER 4–23 DAYS | DURATION OF CONFUSION 21 DAYS OR LONGER | 10–20 DAYS | 3–9 DAYS |
|---|---|---|---|---|---|
| Number of cases | 39 | 5 | 10 | 12 | 12 |
| Mean age (years) | 39 | 52 | 41 | 48 | 24 |
| Decreased incidence (percentage): | | | | | |
| Bloody spinal fluid | 90 | 100 | 100 | 91 | 75 |
| Pressure above 200 mm. of water on lumbar puncture | 74 | 80 | 90 | 82 | 50 |
| Skull fracture | 65 | 80 | 80 | 55 | 50 |
| Restlessness | 64 | 60 | 80 | 58 | 58 |
| Acute alcoholism | 62 | 60 | 70 | 67 | 42 |
| History of chronic alcoholism | 50 | 40 | 60 | 58 | 36 |
| Perseveration | 48 | 40† | 89 | 50 | 16 |
| Confabulation | 39 | 20† | 56 | 58 | 8 |
| Dysphasic disorder of speech or perception | 36 | 25† | 80 | 25 | 8 |
| Skull operation | 36 | 40 | 60 | 25 | 25 |
| Temperature above 103°F. | 31 | 80 | 40 | 31 | 0 |
| Irritability | 28 | — | 60 | 17 | 25 |
| Behavior problem | 26 | — | 70 | 8 | 17 |
| Stupor | 23 | 40† | 50 | 17 | 0 |
| Subdural or extradural hemorrhage* | 27 | 75 | 30 | 27 | 17 |
| Incoherence | 18 | 20† | 60 | 0 | 0 |
| Convulsions | 15 | 40 | 40 | 0 | 0 |
| Increased incidence (percentage): | | | | | |
| Apathy | 33 | — | 30 | 25 | 58 |
| Euphoria and moria | 10 | — | 0 | 25 | 8 |

*Verified at operation or autopsy.

†The percentage given is that of the total number of cases, regardless of whether death supervened before normality had returned.

injuries with complications. Four had sustained skull fractures — 3 basilar and 1 compound. All had experienced contusion and laceration of the brain. Of the 4 with subdural hemorrhages, 3 died within the first six days, 2 of them despite operation; the fourth lingered for twenty days, finally dying of septicemia. A seventy-two-year-old man lived for twenty-three days and developed an acute terminal meningitis with epileptiform seizures. At autopsy he was found to have an old *plaque jaune* with a large area of recent softening, in addition to some contusion and laceration. One patient was explored a second time for a subdural hematoma when he failed to improve after removal of a large subdural hemorrhage, but only an extensive area of softening was discovered. An elderly woman with a compound skull fracture, multiple fractures, early surgical shock and subdural hemorrhage remained in coma for six days before death.

*Duration of Signs*

The mean duration of the various findings is shown in Figure 1. The ability to speak returned early, on an average during the first day, and usually immediately after the reappearance of reflex activity as coma subsided. The first response to simple psychologic tests was not attained until the second week, but this degree of improvement was preceded by correct orientation in place, situation and time. Of the vital signs, the respirations returned to normal first, then the temperature and last the pulse. As might be expected, the duration of abnormal signs varied directly according to the duration of confusion, although pulse fluctuation was an exception to this general rule.

In Table 3 it will be seen that the order of events in recovery varied in the three groups of confused patients who ultimately recovered. The variations chiefly concern the duration of abnormalities in respiration, temperature and pulse. The order of recovery from speechlessness, incontinence and disorientation in place, situation and time was the same in all. Drowsiness persisted longer in relation to those with less prolonged confusion. Restlessness requiring restraint lasted relatively longer in the patients with moderate durations of confusion than in those with shorter or longer disorientation.

None of the patients who died responded to the simplest psychologic tests before death, and 80 per cent of those longest confused were not testable during hospitalization. Only 13 per cent of those disoriented for ten to twenty days were completely incapacitated in this respect throughout their stay, whereas subjects with the shortest confusion could be tested. At the end of three months, 3 patients with dementia (9 per cent of the surviving 34 patients) and 7 with intellectual impairment (21 per cent) had had a period of confusion lasting longer than nineteen days. If these values are converted into figures applicable to all cases of head injury

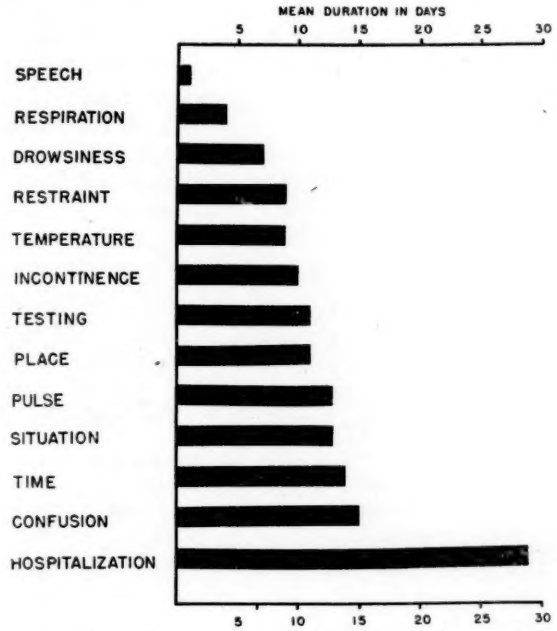


FIGURE 1. *Duration of Abnormal Signs in 39 Cases with Prolonged Confusion following Head Injury.*

TABLE 3. *Duration of Abnormal Findings According to Duration of Confusion.*

| FINDING | ALL CASES | DEATH AFTER 4–23 DAYS* | DURATION OF CONFUSION: 21 DAYS OR LONGER | 10–20 DAYS | 3–9 DAYS |
|---|---|---|---|---|---|
| | *day* | *day* | *day* | *day* | *day* |
| Lack of speech | 1 | 2 | 2 | 1 | 1 |
| Abnormal rate of respiration | 4 | 10 | 6 | 4 | 2 |
| Drowsiness | 7 | 6 | 9 | 8 | 5 |
| Restraint | 9 | 13 | 17 | 8 | 2 |
| Abnormal fluctuation in temperature | 9 | 14 | 11 | 9 | 8 |
| Incontinence | 10 | 13 | 19 | 7 | 2 |
| Inability to respond to tests | 11 | — | 24 | 6 | 4 |
| Disorientation as to place | 11 | 13 | 29 | 7 | 4 |
| Abnormal fluctuation in pulse | 13 | 12 | 15 | 5 | 10 |
| Disorientation in situation | 13 | 13 | 33 | 10 | 3 |
| Disorientation in time | 14 | 13 | 33 | 12 | 6 |
| Hospitalization | 29 | 12 | 41 | 34 | 22 |

*In the patients who died many signs persisted until death, and the duration of the sign in each case was the same as for the period from injury to death. The mean duration was calculated, nevertheless, in order to show that some signs persisted longer on the average than did others, even when death supervened.

studied at this hospital, regardless of duration of confusion, approximately 2 per cent of all patients had marked and probably permanent intellectual defect at the end of three months.

All 14 cases listed under the heading of dysphasia suffered from impairments in perception and execution associated with confusion. Understanding of spoken and written language, as well as ability to read and write, was disturbed in all cases. In only 4 patients was the disturbance of speech such as to indicate localized cerebral damage, and of these, two had a "jargon dysphasia." The majority of these patients had a disturbance in the understanding of the meaning of sentences that lasted longer than the period of disorientation.

Table 4. *Comparison of Durations of Coma or Semicoma and of Confusion.*

| Duration of Coma or Semicoma | All Cases | Death after 4–23 Days* | Duration of Confusion | | |
|---|---|---|---|---|---|
| | | | 21 days or longer | 10–20 days | 3–9 days |
| Unknown | 1 | 0 | 1 | 0 | 0 |
| Less than 1 hour | 10 | 1 | 0 | 6 | 3 |
| 1–5 hours | 16 | 2 | 6 | 2 | 6 |
| 6–11 hours | 5 | 1 | 0 | 2 | 2 |
| 12–24 hours | 5 | 0 | 2 | 2 | 1 |
| Above 24 hours | 2 | 1 | 1 | 0 | 0 |
| Totals | 39 | 5 | 10 | 12 | 12 |

Table 5. *Aftereffects of 29 Patients.**

| Status | No. of Cases | Percentage |
|---|---|---|
| Asymptomatic patients | 11 | 38 |
| Patients with symptoms after hospitalization†: | 18 | 62 |
| Headache | 11 | 38 |
| Dizziness | 12 | 41 |
| Weakness and easy fatigability | 7 | 24 |
| Insomnia | 1 | 3 |
| Disturbance of sexual function | 1 | 3 |
| Fear, anxiety and worry | 3 | 10 |
| Patients with neurologic signs after hospitalization†: | 9 | 31 |
| Cranial nerve palsies | 4 | 14 |
| Babinski's sign | 4 | 14 |
| Unsteady gait | 3 | 10 |
| Dysphasia | 4 | 14 |
| Dysarthria | 1 | 3 |
| Patients with epileptiform seizures | 2 | 7 |
| Patients with change in mental status at end of 6 months‡: | 12 | 41 |
| Dementia | 2 | 7 |
| Partial intellectual impairment | 7 | 24 |
| Marked personality change | 7 | 24 |
| Ability to work: | | |
| Returned to work within 3 months | 15 | 52 |
| Returned to work between 3 and 6 months | 4 | 14 |
| Unable to work at end of 6 months | 4 | 14 |
| Did not work before accident, but capacity estimated to be impaired | 3 | 10 |
| Child (no criteria for adjustment) | 1 | 3 |

*All patients were followed for at least six months, but the figures do not always represent the findings at the end of that time. The signs and symptoms listed were present for variable periods of time following hospitalization.

†There was, of course, some overlapping, some patients having more than one symptom or sign.

‡Patients with dementia are not listed with those having marked personality change, but 5 patients with partial intellectual impairment were adjudged to have striking personality disorders as well. We are indebted to the other members of the research group for data on the ultimate follow-up, and particularly to Dr. Edwin M. Cole for a report on the intellectual status of the patients.

Comparison of the durations of coma or semicoma and mental confusion (Table 4) shows that the relation between the two was not direct.

## Course After Hospitalization

Discussion of the late effects of severe injuries to the head is beyond the scope of this paper. In the light of the long disturbances of consciousness in these patients, however, some consideration is due to their course during the first six months after discharge from the hospital (Table 5). Five patients died during their initial hospitalization after a period of confusion varying from four to twenty-three days; a sixth, who remained demented for more than three months after removal of a subdural hematoma, died after a second exploratory craniotomy. Four patients could not be adequately followed. In 2 cases satisfactory reports concerning the patients were received from other institutions. The remaining 27 patients were examined one or more times in the Head-Injury Clinic of the Boston City Hospital and were followed for at least six months after injury.

A relatively large percentage (38 per cent) of patients remained asymptomatic during the six-month follow-up period. In general, symptoms did not begin after discharge but were existent throughout the post-traumatic course. Sixty-two per cent of patients who were followed had some complaint attributable to their head injury, but in only 2 cases were the symptoms severe. Nine patients had two or more of the symptoms listed in Table 5, whereas 4 presented the classic triad of headache, dizziness and easy fatigability. Headache and dizziness, whenever present, usually lasted for at least two to four months, and in 5 cases each was present for longer than six months. Residual neurologic signs were found in 9 cases (31 per cent), and in most of them persisted in some degree for the entire follow-up period; 2 patients developed epileptiform seizures late in their course. Those patients with marked intellectual impairment a few weeks after injury continued to show the same defect in diminishing degree for at least six months; the incidence of intellectual defect at the end of three and of six months was approximately the same. All 4 cases with dysphasia improved considerably, and at the end of six months it was difficult to demonstrate any defect in 3. Two thirds of the patients who were followed had returned to their usual occupations within six months after injury, and only 14 per cent could be considered completely incapacitated by their head injury at the end of this time.

## Discussion

Prolonged confusion resulting from head injury was accompanied by important changes in vital

signs in about half the 39 patients, and the duration of such changes did not seem to be significantly related to the duration of confusion. From these observations, it seems safe to conclude that mental confusion in patients with head injuries is not primarily the result of respiratory or peripheral circulatory disturbances or elevated body temperature. The evidence, on the other hand, indicates that prolonged confusion is the direct result of severe trauma to the brain, a conclusion supported by the high incidence of findings indicating severe cerebral damage, such as an abnormal electroencephalogram, bloody spinal fluid under increased pressure, extensor plantar responses and skull fracture. From the data obtained in this small series it is not justifiable to conclude that confusion results from increased pressure, the presence of blood in the spinal fluid or a combination of these. Indeed, we are well aware of many cases in which all these were present without prolonged confusion. No combination of signs, apart from those of the mental disorder consequent on the confused state, was invariably present. From the prognostic standpoint, the presence of convulsions during the hospital course, incoherence, stupor or a temperature over 103°F. was particularly important in this series, since these signs were found only in association with the longest confusion. This evidence also supports the theory that fever in such injuries is of cerebral origin, as indicated by Goldstein.[14] The duration of the period of disorientation was prolonged by advancing age and by alcoholism.

Among 190 unselected patients with head injuries previously reported,[9] 9 per cent were in a state of coma or confusion during the first twenty-four hours. The series studied here, in which coma or confusion persisted for longer than three days, constitutes 8 per cent of a larger but overlapping group. These figures suggest that when confusion is present for more than twenty-four hours, it is usually associated with severe cerebral damage and is apt to persist for days or weeks. Although short-lasting disorientation is usually encountered immediately after head injury, this type of disturbance tends to be limited to minutes or hours, and is probably related to alcoholism, to a memory gap or to the emotional factors attendant on loss of consciousness.

In this small series it is interesting that euphoria, moria and apathy were more frequent in the patients in whom the period of confusion was short. It is possible that severe intellectual impairment masks these emotional and personality disturbances, which become more evident when orientation returns.

The order in which the various abnormalities disappeared is constant for speechlessness, incontinence and disorientation in place, situation and time. These are milestones in a gradually progressive improvement in cerebral function. There is, however, a diurnal fluctuation most noticeable in any function for the first few days after its reappearance. In relation to these events in mental awakening, drowsiness and restlessness hold no fixed place, disappearing relatively earlier in the more lengthy confusions. It is possible that they reflect disorder of a different kind, — for example, emotional reaction — for the person with limited consciousness is still capable of such reaction. The duration of abnormality of pulse rate may likewise be related to emotional disturbance as well as to damage to vital centers. Its inconsistency reveals such multiple relations. The motor manifestations, such as inability to speak and extreme restlessness requiring restraint, disappear long before the intellect returns to normal. The duration of the period in which the patient is unable to make any response to simple psychologic tests was found to be a measure of the severity of the confusion, for the duration of such disability was related to the duration of the period of confusion. The first responses were made shortly before normal orientation reappeared.

The cases here reported are included in a larger group investigated by us,[9] in which the incidence of severe intellectual impairment at the end of three months was about 2 per cent. All the patients in the present series with persisting intellectual defect at the end of three and six months had a period of disorientation in excess of nineteen days, an indication that both these disturbances are aspects of the same essential disorder of cerebral function. The mental phenomena of the confused state can be regarded as the initial deeper stage of what later becomes intellectual impairment. This disturbance is complicated by the influence of age and alcoholism. No cases were encountered of disproportion between the severity of confusion and the degree of residual mental defect of the type mentioned by Symonds.[6] These patients are being followed for long periods by the other investigators in the project, and our present intention is simply to give an indication of the clear relation between the early confusion and the later disturbances of the intellectual sphere.

The duration of amnesia is closely related to that of confusion. All the patients in this series appeared to have retrograde and post-traumatic amnesia, but reliable estimate of its duration was obtainable only in retrospect after disorientation and other disturbances had entirely cleared. In the early stages of hospitalization, therefore, the duration of confusion (disorientation) is the best criterion for evaluation of the severity of damage to mental function. Unfortunately, such information is often unavailable when patients are seen late in convalescence, and the post-traumatic period of amnesia is then the only basis on which the duration of disturbed consciousness can be estimated. Whereas post-traumatic amnesia appears to coincide fairly well in duration

with disorientation, measurement of the latter would provide more reliable and more easily obtainable objective data.


## Summary

In 39 patients with prolonged disturbances of consciousness following head injury, the frequency and duration of abnormal signs were analyzed. A high incidence of abnormal findings, such as an altered electroencephalogram, skull fracture, bloody spinal fluid under increased pressure and Babinski's sign, gave evidence that prolonged mental confusion is associated with severe brain damage. Important changes in vital signs were present in only half the cases and appeared to be independent of the presence and duration of confusion.

During the period of hospitalization immediately following injury, intellectual disturbances outnumbered other mental abnormalities. Emotional disorders tended to appear later than the cognitive dysfunctions, and persisted longer; they were frequent even in cases of short confusion.

Ability to speak returned on an average within the first day. The first response to simple psychologic tests appeared during the second week, before correct orientation in place, situation and time, which returned in that order. Drowsiness and restlessness held no fixed place in the order of recovery, and appear to be independent of the course of recovery of intellectual function.

Gross intellectual defect persisted for six months in 31 per cent of the series, and in every case was preceded by a period of confusion lasting longer than nineteen days.

The duration of disorientation proved to be one of the most reliable and easily obtainable criteria of the seriousness of mental prognosis. The total duration of post-traumatic amnesia is directly related to the period of disorientation and thus has equal value, but is available only later and is then a purely subjective quantity.


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# MENINGOCOCCAL MENINGITIS*

## A Report of Thirty-Three Cases with No Deaths


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THIRTY-THREE cases of meningococcal meningitis were admitted to the Contagious Disease Service of the Station Hospital at Camp Grant, Illinois, between January 4 and July 3, 1943. During this period, there were 10 additional cases of acute purulent meningitis, with 1 death. No organisms were found either on repeated spinal-fluid examination or on blood culture. Because the etiology of these cases is not clear, they are not included in this discussion.

Four cases are presented in detail, including one that was complicated by hemorrhage into the adrenal glands (Waterhouse–Friderichsen syndrome). All the patients were adults between the ages of eighteen and thirty-four years.

### *Symptoms*

In most cases the onset was acute, with severe headache, chills, fever and vomiting (Table 1). Less frequently there was an associated cough, sore throat and nasal discharge. The admission temperatures varied from 98 to 104.4°F., with an average of 100.8°F. Fever persisted on an average of 5.1 days, with a variation of one to fifteen days.

Table 1. *Frequency of Symptoms.*

| Symptom | No. of Cases | Percentage |
|---|---|---|
| Headache | 32 | 97 |
| Fever | 32 | 97 |
| Vomiting | 30 | 91 |
| Chills | 24 | 73 |
| Sore throat | 12 | 36 |
| Cough | 11 | 33 |
| General aching | 8 | 24 |
| Nasal discharge | 6 | 18 |

### *Physical Signs*

A rigid neck was present in all 33 patients, and a positive Kernig sign was elicited in all but 2 (Table 2). Coma, semicoma or drowsiness occurred frequently. Skin manifestations, usually in the form of petechiae, were not uncommon. Occasionally,

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a generalized pink macular or maculopapular rash was seen. Neck rigidity persisted on an average of 6.6 days, with a variation of two to seventeen days.

*Laboratory Findings*

A total and a differential cell count, a Pandy's test, a sugar determination, a stained smear and a culture on chocolate agar (incubated in an atmosphere containing 10 per cent carbon dioxide) were routinely performed on all spinal fluids. In all but 1 case, the diagnosis of meningococcal meningitis was confirmed by the presence of the characteristic gram-negative intracellular diplococci in the smear of the spinal fluid or by their isolation in culture. In the remaining case, which presented the typical clinical and laboratory findings of an acute meningitis, the organisms could be isolated only in blood culture. On initial examination the spinal fluid was frankly purulent in all but 2 patients. The first lumbar puncture in these cases revealed a clear, colorless fluid containing only a few lymphocytes, but a tap repeated several hours later revealed the presence of many polymorphonuclear leukocytes.

Table 2. *Frequency of Physical Signs.*

| Physical Sign | No. of Cases | Percentage |
|---|---|---|
| Stiff neck | 33 | 100 |
| Kernig's sign | 31 | 94 |
| Skin manifestations: | 20 | 61 |
| Petechiae alone | 13 | 40 |
| Petechiae and purpura | 3 | 9 |
| Petechiae and maculopapular rash | 3 | 9 |
| Maculopapular rash alone | 1 | 3 |
| Drowsiness | 11 | 33 |
| Coma | 9 | 27 |
| Delirium | 3 | 9 |

Eighteen of the 33 patients had spinal-fluid cell counts of 5000 to 20,000, with 74 to 100 per cent polymorphonuclear leukocytes (Table 3). The organism was seen in the spinal-fluid smear in 27 cases (82 per cent). Spinal-fluid culture was positive in 26 cases (80 per cent). Group 1 meningococci were found in all cultures that could be successfully typed (21 cases). In only 17 cases (51 per cent) was the spinal-fluid sugar decreased. Eleven patients (33 per cent) had a positive blood culture. The white-cell count of the blood in most cases varied between 15,000 and 25,000, with a moderate to marked polymorphonuclear leukocytosis.

Table 3. *Cell Counts of the Initial Spinal Fluids.*

| White-Cell Count | No. of Cases | Percentage |
|---|---|---|
| Less than 1,000 | 3 | 9 |
| 1,000-4,000 | 8 | 24 |
| 5,000-9,000 | 9 | 27 |
| 10,000-19,000 | 9 | 27 |
| 20,000-39,000 | 3 | 9 |
| 40,000 or over | 1 | 3 |

*Treatment*

Treatment in almost all cases was begun in twenty-four hours or less after the onset of symptoms. Sulfadiazine, sulfathiazole and polyvalent antimeningococcus serum were used singly or in combination. The way in which these therapeutic agents were employed is summarized in Table 4.

When sulfathiazole and sulfadiazine were used in combination, intravenous sodium sulfathiazole was the drug employed to initiate treatment. This was followed by oral sulfadiazine as soon as the patient was able to take medication by mouth. When sulfadiazine was used exclusively, the sodium salt of sulfadiazine was substituted for the sodium sulfathiazole, which was used only when sodium sulfadiazine was not available, the latter drug being preferred because of its lower toxicity. In general, treatment was initiated by giving intravenously 5 gm. of sodium sulfadiazine or sodium sulfathiazole dissolved in 100 cc. of distilled water. If oral sulfadiazine could not be given within twelve hours after the onset of treatment, the intravenous administration of sulfonamide was repeated. As a rule it was unnecessary to repeat the parenteral injection more than once, since at the expiration of twenty-four hours the patient was usually able to take sulfadiazine by mouth. When oral therapy was begun, 1 or 2 gm. of sulfadiazine was given every four hours, the larger dose usually being employed for only twenty-four to forty-eight hours, depending on the blood level of the drug. Thereafter, sulfadiazine was continued in doses of 1 gm. every four hours until the patient was afebrile for one week, whereupon therapy was abruptly discontinued. Since most patients were afebrile after the fifth day, the average case received sulfadiazine for eleven or twelve days.

Table 4. *Type of Treatment.*

| Therapeutic Agent or Agents | No. of Cases | Percentage |
|---|---|---|
| Sulfadiazine alone | 14 | 43 |
| Sulfadiazine and sulfathiazole | 14 | 43 |
| Sulfadiazine and serum | 2 | 6 |
| Sulfadiazine, sulfathiazole and serum | 3 | 9 |

The dosage of sulfadiazine was governed to some extent by the blood level of the drug. An attempt was made to obtain a blood-sulfadiazine level of 8 to 12 mg. of the free drug per 100 cc., preferably by the second day of treatment. When the blood level was much below 8 mg., however, no attempt was made to increase the blood level by giving larger than the usually recommended doses of sulfadiazine if the patient seemed to be making satisfactory progress. In Table 5 are given the blood and spinal-fluid sulfadiazine levels of 14 patients who received sulfadiazine exclusively.

The twenty-four-hour fluid intake and urinary output were measured for all patients receiving sulfonamide therapy. This was considered to be of the utmost importance. A urinary output of not less than 1500 cc. every twenty-four hours was desired. If it was less than this, fluids were forced by mouth or intravenously to prevent anuria.

Polyvalent antimeningococcus serum was used in conjunction with a sulfonamide drug in 5 cases.

Its use was reserved for markedly fulminating cases and for those that seemed to be responding poorly to sulfonamide therapy. Despite negative intradermal and intraocular tests in all cases, a reaction to the serum was encountered in 2 patients, chills and headache occurring during administration — apparently an anaphylactic reaction. In the remaining 3 cases, serum therapy was followed one week later by urticaria and arthralgia.

Routine spinal-fluid drainage was not performed. All patients received a minimum of two lumbar punctures — one for diagnosis and the other for checkup before discharge from the hospital. Indications for additional lumbar punctures were persistent, severe headache, frequent vomiting and a slow or doubtful clinical response to therapy. In the last instance, repeated spinal-fluid examination was required so that the progress of the patient could be followed more closely.

Morphine sulfate in doses of 1/6 or 1/4 gr. was found to be the drug of choice for the control of headache and restlessness. In delirium, however, this drug was found to be of little or no value. In a wildly excited patient with true delirium, intravenous Pentothal Sodium was used, with gratifying success. Pentothal Sodium employed in this manner has the disadvantage of an extremely short-lived effect. This difficulty was overcome by slow, continuous administration, made possible by diluting the drug with a large quantity of normal saline solution. A total of 1 gm. of Pentothal Sodium was employed. To quiet the patient approximately one fourth of this amount, or 0.25 gm., was given intravenously as a 2.5 per cent solution in distilled water. The remainder, or 0.75 gm., was added to 1000 cc. of normal saline solution and given intravenously at a rate that just kept the patient from restlessness. The administration of this solution required about six hours. Repetition of the drug was unnecessary. The usual precautions for its administration were observed, and a trained attendant was constantly present.

*Complications*

A serious complication was encountered in only 1 case, this consisting of a probable hemorrhage into the adrenal glands (Waterhouse–Friderichsen syndrome[1–3]). This case is presented in detail below. Another patient, who had apparently made a satisfactory recovery, returned two months after discharge with the signs and symptoms of a chronic meningoencephalitis of unknown etiology. A third patient, who had made an uneventful recovery, was discovered to have an unrelated active, minimal case of pulmonary tuberculosis. The remaining complications were minor and transient. Eleven patients (33 per cent) developed herpes simplex and 2 (6 per cent) had a transient diplopia.

TABLE 5. *Blood and Spinal-Fluid Sulfadiazine Levels of Patients Treated with Sulfadiazine Only.*

| Case No. | Day of Treatment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2nd mg./100 cc. | 3rd mg./100 cc. | 4th mg./100 cc. | 5th mg./100 cc. | 6th mg./100 cc. | 7th mg./100 cc. | 8th mg./100 cc. | 9th mg./100 cc. | 10th mg./100 cc. |
| 1 | 2.52 | | 10.1 | | 8.0 | | | | |
| | | (1.1) | | | | | | | |
| 2 | 7.3 | 1.3 | 4.6 | | 8.7 | | 10.1 | | 8.4 |
| | | (9.6) | (7.15) | | | | | | |
| 3 | 7.4 | 10.5 | 7.15 | | | | 11.0 | | |
| 4 | 8.2 | 7.7 | | | | 8.9 | | | 9.7 |
| 5 | | 6.4 | | 11.0 | | 8.69 | | | |
| | | (4.96) | | | | | | | |
| 6 | 8.8 | 7.15 | 7.85 | | 8.99 | | 11.6 | | |
| 7 | 2.32 | | | 11.6 | | | | 7.51 | |
| | | | (2.84) | | | | | | |
| 8 | 6.3 | 6.6 | 4.8 | | | 7.7 | | | |
| | (8.0) | | | | | | | | |
| 9 | 9.7 | 12.9 | 7.7 | | | 6.4 | | | |
| 10 | 4.8 | 6.3 | | 9.7 | | | | | |
| 11 | 9.2 | | 7.63 | | | | 8.4 | | |
| 12 | | 6.4 | | 9.7 | | | 10.5 | | |
| | (3.6) | | | | | | | | |
| 13 | 5.3 | 8.1 | | | | 7.0 | | | |
| 14 | | 5.2 | | 9.2 | | | | | 10.9 |

*The spinal-fluid levels are given in parentheses.

## Case Reports

The first two cases present the usual picture of an uncomplicated acute meningococcal meningitis.

Case 1. G. H., a 19-year-old soldier, was admitted to the hospital complaining of headache, vomiting and chills that had begun a few hours previously. The past medical history and the family history were noncontributory.

Physical examination revealed a well-developed, well-nourished, conscious but stuporous man. The temperature was 104°F., the pulse 120, and the respirations 20. Neck rigidity was marked. Kernig's sign was positive, and the deep tendon reflexes were normally active. The skin was clear. A lumbar puncture revealed a cloudy spinal fluid containing 8530 white cells per cubic millimeter, of which 96 per cent were polymorphonuclear leukocytes and 4 per cent lymphocytes. The spinal-fluid smear showed an occasional pair of gram-negative extracellular diplococci. Spinal-fluid culture was positive for Group 1 meningococci. A blood culture was negative. The blood white-cell count was 20,100, with 95 per cent polymorphonuclear leukocytes and 5 per cent lymphocytes.

The patient was given 5 gm. of sodium sulfadiazine in 100 cc. of distilled water intravenously and 4 gm. of sulfadiazine by mouth, and 1 gm. of sulfadiazine thereafter every 4 hours for 11 days.

Recovery was uneventful, all clinical signs of meningitis disappearing by the 5th hospital day. The only complication was the development on the 11th day of a drug rash and fever, which quickly subsided when the sulfadiazine was discontinued.

Case 2. G. M., a 29-year-old soldier, had been well until 1 day prior to admission, when he developed severe headache,

soreness of the neck, chills and vomiting. The past medical history and the family history were negative.

Physical examination revealed a conscious but drowsy man. The temperature was 104.2°F., the pulse 112, and the respirations 24. The skin was clear. The pharynx was slightly injected. Neck rigidity was marked. Kernig's and Brudzinski's signs were markedly positive. A lumbar puncture revealed a cloudy spinal fluid containing 22,470 white cells per cubic millimeter, of which 94 per cent were polymorphonuclear leukocytes. The globulin was markedly increased. The spinal-fluid sugar level was 4.2 mg. per 100 cc. A smear showed gram-negative intracellular diplococci, and culture of this fluid yielded Group 1 meningococci. A blood culture was negative. The blood white-cell count was 14,400, with 74 per cent polymorphonuclear leukocytes and 20 per cent lymphocytes.

The patient was given 5 gm. of sodium sulfathiazole in 100 cc. of distilled water intravenously and 2 gm. of sulfadiazine by mouth, followed by 1 gm. every 4 hours. On the 2nd day, because of apparent failure to improve clinically and a low blood-sulfonamide level, — 2.12 mg. per 100 cc., — 4 gm. of sulfadiazine was given by mouth, followed by 2 gm. every 4 hours for the next 7 days. By the 8th day of treatment the blood-sulfadiazine level had reached 10.3 mg. per 100 cc. Thereafter the patient received 1 gm. of oral sulfadiazine every 4 hours until the 11th day, when therapy was discontinued. The only reaction possibly attributable to the sulfadiazine was a transient microscopic hematuria.

Recovery was uneventful, all clinical signs of meningitis having disappeared by the 7th hospital day.

The next case was probably complicated by hemorrhage into the adrenal glands.

Case 3. J. B., a 23-year-old soldier, was admitted to the hospital with a chief complaint of headache. He had been well until 2 days prior to admission, when he developed a sore throat and a slight cough. A few hours before admission he began having severe headache, chills, fever and vomiting.

Physical examination revealed an acutely ill man who was conscious but drowsy. The temperature was 103.2°F., the pulse 136, and the respirations 26. There were numerous petechiae and many areas of marked purpura over the trunk and extremities. There were also a few purpuric spots over the soft palate and a small hemorrhage beneath the left bulbar conjunctiva. The pharynx was moderately inflamed. Neck rigidity was marked. The Kernig and Brudzinski signs were positive. The deep-tendon reflexes were normally active. The heart sounds were of fair quality. The blood pressure was 70/45. A lumbar puncture revealed cloudy spinal fluid under slightly increased pressure. The white-cell count was 8675, with 77 per cent polymorphonuclear leukocytes and 23 per cent lymphocytes. The globulin was markedly increased, and the sugar level was 55.5 mg. per 100 cc. A smear showed numerous gram-negative intracellular diplococci. Cultures of the fluid and the blood were both positive for Group 1 meningococci. The blood white-cell count was 23,100, with 95 per cent polymorphonuclear leukocytes and 5 per cent lymphocytes.

The patient was given 5 gm. of sodium sulfadiazine intravenously, followed by 1 gm. of oral sulfadiazine every 4 hours. A few hours after treatment was begun, he lapsed into a restless coma. There was slight cyanosis, the pulse became imperceptible, and the blood pressure could not be obtained. Unlike the usual picture of shock, the veins were full and the extremities were warm and moist. The blood chloride level was 216 mg. per 100 cc., and the blood sugar level 97 mg. Because of the clinical picture resembling shock, the low blood-chloride level and the striking purpura, it was thought that a hemorrhage into the adrenal glands had occurred. Accordingly the patient was given large quantities of normal saline solution intravenously, adrenocortical extract intravenously and intramuscularly, a 500-cc. blood transfusion and oxygen intranasally. Within 3 hours the blood pressure had risen to 70/55. Several hours later the patient regained consciousness. The blood chloride level several days after this acute episode was 472 mg. per 100 cc.

Further treatment with sulfadiazine and intravenous polyvalent antimeningococcus serum brought about a slow but uneventful recovery.

The last case, one of unusual interest, is presented to show that meningococcal meningitis cannot be ruled out on the basis of a single negative spinal-fluid examination. It further serves to illustrate how quickly the spinal-fluid picture can change.

Case 4. E. A., a 28-year-old soldier, was admitted to the hospital complaining of headache, chills, general aching, sore throat and vomiting that had begun several hours before.

Physical examination presented an acutely ill patient who was conscious but drowsy. The temperature was 100.8°F., the pulse 100, and the respirations 20. There were a few widely scattered petechiae over the trunk and extremities. The pharynx was moderately injected, the neck was slightly rigid, and Kernig's sign was positive. The deep-tendon reflexes were sluggish. A lumbar puncture revealed clear, colorless spinal fluid under normal pressure. It contained only 6 cells per cubic millimeter, all of which were lymphocytes. No organisms were seen on smear, the globulin was not increased, and the sugar level was 83 mg. per 100 cc. The blood white-cell count was 46,650, with 91 per cent polymorphonuclear leukocytes.

The patient was treated symptomatically. Within a few hours the number of petechiae had increased, the neck became more rigid, and Kernig's sign was more markedly positive. Five hours after the first spinal-fluid examination, lumbar puncture was repeated. At that time, the spinal fluid was cloudy and under increased pressure and showed a cell count of 7450, with 95 per cent polymorphonuclear leukocytes and 5 per cent lymphocytes. The globulin was markedly increased, the sugar level was 46.5 mg. per 100 cc., and a smear showed numerous gram-negative intracellular diplococci. Culture of the spinal fluids from the two lumbar punctures showed Group 1 meningococci. The blood culture was also positive for meningococci.

Following treatment with intravenous sodium sulfathiazole and oral sulfadiazine, the patient made an uneventful recovery.

## Summary

The symptoms, physical signs, laboratory findings and treatment of 33 cases of meningococcal meningitis are presented.

The therapeutic agents employed were sulfadiazine, sulfathiazole and polyvalent antimeningococcic serum.

In this unselected series of cases there were no deaths.

Only one serious complication was encountered — an apparent hemorrhage into the adrenal glands (Waterhouse–Friderichsen syndrome).

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# MEDICAL PROGRESS

## INHALATION THERAPY*

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INHALATION therapy may be defined as the administration of gases through the respiratory system for the treatment of various types of anoxia or of oxygen want of the tissues. The indications and value of oxygen therapy have been reported by Boothby and his associates, Barach and his associates and others. The principal use of oxygen is to relieve the anoxia that occurs in a wide variety of disturbances of the circulatory, respiratory and central nervous systems, in preoperative and postoperative conditions and in military medicine. Such therapy has had an amazing growth.

Other therapeutic gases, agents and methods of maintaining respiratory function have been developed. Inhalations of carbon dioxide, helium-and-oxygen mixtures, of water-vapor and of nebulized sprays of various therapeutic agents, repeated bronchial relaxation therapy, the addition of positive pressure with oxygen or helium-and-oxygen mixtures and continuous pulmonary-arrest therapy have been increasingly employed, with successful results. It is beyond the scope of this report to review the many papers that have been written on these subjects. Only those that appear to be especially significant will be considered.

### EQUIPMENT

Excellent reviews of the various types of equipment may be found in papers by Boothby and his associates,[1-5] Eckman and Barach[6-10] and Ellis[11] and in a small manual recently published by Andrews.[12] The more frequently used methods for administering oxygen are the nasal or nasopharyngeal catheter, face masks and tents and the various types of enclosing tents. Each method has its special advantages and disadvantages. With the above methods, oxygen can be given in 40 to 70 per cent concentrations.

The development of the B.L.B. apparatus in 1938 and its later modifications[13, 14] make it possible to administer concentrations of oxygen close to 100 per cent. This is partially a rebreathing type of apparatus and can be used for helium-and-oxygen and carbon dioxide therapy. Barach and Eckman[6, 7] in a careful analysis reported the disadvantages of the B.L.B. apparatus — namely, the accumulation of carbon dioxide and the development of negative and positive pressures within the mask at low flows of oxygen owing to the resistance of the sponge-rubber valves. These disadvantages can be largely corrected by using high flows of oxygen. A critical discussion and analysis of the B.L.B. apparatus, with determinations of the percentages of alveolar air and carbon dioxide at various flows of oxygen and comparison with the Christie and Haldane masks, appeared in the English literature in a paper by Card et al.[15]

In a recent paper Barach and Molomut[16] describe a new modification of the Barach–Eckman apparatus. This mask is a distinct credit to the ingenuity of the authors and is of tremendous practical value. An air injector is utilized to provide accurately controlled percentages of oxygen in the inspired air. By means of an expiratory valve on the face mask, which is a comfortable one, and an inspiratory valve at the entrance to the collecting bag, rebreathing is eliminated. Accumulation of carbon dioxide and mechanical resistance to respiration are greatly reduced with this arrangement of valves. A soft latex-rubber collecting bag of 1000-cc. capacity makes it possible for the patient to breathe deeply with comfort. In addition the face mask has an attached expiratory outlet that has been metered for positive pressure in expiration up to 4 cm. of water pressure. A higher positive pressure develops during dyspnea when the 4-cm. orifice is used. The apparatus can be used to deliver 40 to 95 per cent oxygen or helium-and-oxygen mixtures, with or without positive pressure. If carbon dioxide therapy is prescribed, the inspiratory valve may be removed to allow rebreathing. I[17, 18] have used this apparatus in various types of cardiorespiratory disease and find it practical and economical. Cowan and Mitchell[19] made a critical analysis of the mask and attest to its improved functional value. Epstein[20] compared the pressure changes taking place in the nasal piece of this apparatus with those in the nasal piece of a standard B.L.B. mask. He confirmed the previous observations by Barach and Eckman that the pressure changes during inspiration and expiration are considerably smaller with the injector apparatus than with the B.L.B. mask. When using higher concentrations of oxygen with the B.L.B. mask he observed an increasing rise of pressure against expiration. The variations in pressure in the meter mask were found to be the same at all flows and less in all cases than in the B.L.B. mask.

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The helium-and-oxygen hood rebreathing apparatus[9, 10] is the most effective one for giving oxygen or helium-and-oxygen mixtures, with or without positive pressures. The percentage concentrations of the mixtures can be exactly controlled. Positive pressures up to 6 cm. of water can be applied to the inner surface of the lung during both inspiration and expiration. The apparatus consists of a gas-tight motor blower, two canisters for the carbon dioxide absorber, a rheostat to determine the volume of air flow and its temperature, tubal connections, an ice-containing cabinet and a plastocele hood in which the patient's head lies, with closure effected by a soft-rubber collar. In this rebreathing circuit only the oxygen is used up when enclosed. Cooling, dehumidification and removal of carbon dioxide can be efficiently carried out. The apparatus is widely employed in the treatment of severe bronchial asthma, various types of pulmonary edema and obstructive dyspnea.

A new apparatus for administering oxygen is described by Bortin.[21] The exhaled air passes through a carbon dioxide absorber and thence into a reservoir bag. When the bag is sufficiently inflated, the purified air returns to the patient. The automaticity depends on an ingenious series of valves. This is an economical method of giving oxygen, since little, if any, of the gas is wasted. It appears to have a real value in aviation, where conservation of weight and space is important. Alveolar concentrations of oxygen and carbon dioxide at varying rates of flow have not yet been reported with this apparatus. The many mechanical factors necessary for maintenance, however, probably preclude its general use.

A new apparatus for the administration of helium-and-oxygen mixtures is described by Brubach, Crisp and Neal.[22] Separate tanks of helium and oxygen are used, and safety devices regulate the flow of the two gases in accordance with the patient's needs. A safety valve prevents the flow of helium until the oxygen is turned on. An adjustable weight arrangement makes possible the maintenance of a positive pressure in the facepiece. This apparatus permits a wide selection of the percentages of the gases, and when set for 20 per cent oxygen the latter cannot fall more than a fraction of 1 per cent. It is a seemingly foolproof device if all goes well and attention is paid to the many functioning parts: valves, bellows, beam, weights, flow meter and so forth. Any desirable combination of helium and oxygen, with or without positive pressure, however, can be given with safety and relative inexpensiveness with the most ideal apparatus — the Barach–Eckman–Molomut mask apparatus,[16] previously described.

An equalizing pressure chamber for immobilizing the lungs by air pressure is described by Barach.[23–26] The total pressures on both sides of the diaphragm are made equal. Under these circumstances adequate ventilation of the lungs is accomplished without voluntary breathing and without discernible movement of the ribs and diaphragm. Four out of five patients with advanced pulmonary tuberculosis considered unsuitable for any type of collapse therapy showed a consistent response to equalizing-pressure therapy — namely, a marked gain in weight, a decrease in cough and sputum, a fall in the sedimentation rate and the temperature to normal, definite clearing of shadows on the x-ray film, including cavities, and subjective improvement. This form of therapy, although at present impractical on a large scale, shows promise for the candidate for pneumothorax or thoracoplasty with advanced pulmonary tuberculosis.

## Carbon Dioxide Therapy

The principal use of carbon dioxide therapy is to stimulate the respiratory center. An increase in the respiratory rate and in the depth of respirations characterizes effective therapy of this type. Carbon dioxide probably acts by increasing the acidity of the respiratory center. Increase in the acidity of the blood flowing through the carotid body and low oxygen pressures in the carotid body also stimulate breathing. In addition, carbon dioxide shifts the oxygen-dissociation curve to the right and dilates the cerebral vessels.

### *Physiologic Effects*

In seeking to understand the rationale of carbon dioxide administration, it is well to recall that Gibbs, Gibbs and Lennox[27] demonstrated a selective increase in cerebral flow by an increased carbon dioxide tension. Behnke, Forbes and Motley[28] similarly observed an increase of 33 per cent in the diameter of the pial vessels of the cat as a result of increasing the pulmonary, carbon dioxide tension. Shaw, Behnke and Messer[29] also believe that, apart from the shift of the oxygen-dissociation curve to the right with high carbon dioxide tensions, increased cerebral circulation accompanying carbon dioxide inhalations in part explains the increased effectiveness of a given pulmonary oxygen tension. The supply of blood to the vital centers is augmented by the cerebral vasodilatation. The above observations offer a partial explanation of the ability of increased pulmonary carbon dioxide tension to improve the effectiveness of oxygen on the central nervous system.

Gellhorn[30] demonstrated that the anoxia and circulatory collapse observed in human subjects when breathing atmospheres of only 8.5 per cent oxygen could be prevented by adding 3 per cent carbon dioxide to the atmospheres breathed. He attributed this to the action of carbon dioxide in increasing the respiratory volume, venous return and cerebral blood flow, stimulating the respiratory center and shifting the oxygen-dissociation curve so that the supply of oxygen to the tissues is augmented. The anesthetist thus has a simple physi-

ologic method for increasing cerebral blood flow with mixtures of carbon dioxide and oxygen, although this is not necessary if the oxygen concentration of the anesthetic mixture is kept above 20 per cent.

It is important to know when carbon dioxide ceases to stimulate and acts as a narcotic. Brown[31] demonstrated that the therapeutic effect depends on whether the action is stimulating or narcotic. He showed that the respiratory minute volume in healthy men was increased 279 per cent by a 10.4 per cent concentration of carbon dioxide in the inspired air, although at concentrations above 7.5 per cent the increase was negligible. Above 10.4 per cent, a decrease in minute volume from the maximum began.

The efficacy of carbon dioxide in carbon monoxide poisoning is due not merely to stimulation of respiration but, as Stadie and Martin[32] point out, to the displacement of carbon monoxide by carbon dioxide. Small concentrations of carbon dioxide (1 to 2 per cent) in the presence of 50 per cent oxygen may also enhance the effectiveness of oxygen by increasing its movement from the blood to the tissues (Bohr effect).

*Therapeutic Uses*

Carbon dioxide-and-oxygen therapy has been reported to be of value during and after anesthesia, in the treatment of various asphyxias, electric shock, drowning, morphine poisoning, atelectasis neonatorum, postoperative atelectasis, epilepsy and dementia praecox and as an expectorant. The B.L.B. or Barach meter mask may be used, employing concentrations of 3 to 10 per cent carbon dioxide in oxygen.

Henderson and his associates[33–47] first emphasized the value of carbon dioxide in depressed respiratory states, particularly those due to carbon monoxide poisoning. They[48–53] extended its use to cardiorespiratory lesions characterized by dyspnea. Barach[54] decried this extended usage and proved its physiologic unsoundness. Other investigators questioned its value in asphyxia and atelectasis. Eastman, Dunn and Kreiselman[55] made a study of the relative value of pure oxygen and of carbon dioxide mixtures in experimental resuscitation. Their work showed that oxygen is of the greatest importance in the treatment of asphyxia in dogs and that the effect of giving carbon dioxide in this condition is actually harmful. They concluded that the indiscriminate use of carbon dioxide should be guarded against in the resuscitation of the asphyxiated. Increasing evidence by Kane[56] favors the use of oxygen or helium-and-oxygen mixtures, with and without positive pressure, in place of carbon dioxide in the management of various types of atelectasis. He thought that the increased respiratory effort produced by carbon dioxide would be harmful with an obstructive respiratory picture, since it tended to increase the intrathoracic negative pressure, thus producing pulmonary edema. This could be prevented by using oxygen or helium-and-oxygen mixtures, particularly with positive pressure. Martinez[57] also prefers pure oxygen to oxygen and carbon dioxide. He employed a pulmotor in a series of 500 infants and believed it to be the most effective method of resuscitating babies.

The Council on Pharmacy and Chemistry,[58] in an excellent review of the status of oxygen-and-carbon dioxide therapy, states that, since there has been no adequate evidence of a state of carbon dioxide deficiency of sufficient severity or frequency in clinical disease, the value of such therapy cannot be explained on a deficiency basis. Furthermore, no adequate evidence has yet been presented proving the value of such mixtures in the routine therapy of pneumonia or heart disease.

Considerable controversy still exists concerning the over-all value of carbon dioxide inhalation as an expectorant in pulmonary disease. Alison[59] used inhalations of 5 per cent carbon dioxide with oxygen in some cases of beginning pneumonia and bronchitis in children. He thought that the disease process was aborted through the removal of the mechanical blocking of the airways. Banyai[60] used inhalations of 10 per cent carbon dioxide in oxygen in cases of pulmonary tuberculosis. He observed that the increase in respiratory rate was followed by easier expectoration and a decrease of cough. Large amounts of sputum were raised by almost effortless expectoration. The sputum changed from a heavy, thick and tenacious type to a thin, serous and watery form. Banyai and Cadden[61] more recently confirmed the value of carbon dioxide inhalation as an expectorant in pulmonary tuberculosis. They attribute its effectiveness to a powerful respiratory stimulating effect, which reflects itself in a stretching and dilatation of the bronchial tubes, powerful peristaltic movements of the bronchi and liquefaction of the exudate that stagnates in the bronchial tree. They stress its contraindication in recent pulmonary hemorrhage, in severe emphysema, in extensive pulmonary fibrosis without atelectasis, bronchiectasis or mucopurulent retention in the air passages, in acute plastic pleurisy and pleurisy with effusion and in hypertension. Campbell and Poulton[62] encouraged the use of carbon dioxide and oxygen in the treatment of pneumonia.

Basch, Holinger and Poncher[63, 64] made an exhaustively careful study of the physical and chemical properties of sputum, particularly the influence of drugs, steam, carbon dioxide and oxygen. They concluded that inhalations of steam are more effective than drugs in liquefying sputum. Inhalation of carbon dioxide serves as a most efficient expectorant. Such inhalations reduce the amount of sputum within the bronchial tree by stimulating resorption and render the remainder liquid, so that it is easily coughed up. They found the most efficient regimen

to be a combination of carbon dioxide, steam and expectorant drugs. The above observations of Alison, Banyai, Campbell and Poulton, and Basch et al. certainly favor the use of carbon dioxide inhalation as an expectorant. Nevertheless, one should use it only with a full appreciation of its contraindications as described previously by Basch et al., Eastman et al., Kane, Barach and others.

Barach[65] employs 5 to 15 per cent concentrations for the management of hiccoughs with considerable success. With higher concentrations the patient becomes drowsy and profoundly relaxed. He generally begins treatment with a 5 per cent concentration and increases it to 15 per cent for three to ten minutes at each treatment if the patient becomes refractory to the lower percentages.

Kornmüller[66] investigated the influence of 3 to 5 per cent carbon dioxide in oxygen inhalations on the electroencephalographic changes in patients with epilepsy or dementia praecox. The observations demonstrated that carbon dioxide may counteract these changes. He concluded that therapeutic effects may be expected from the use of carbon dioxide in these diseases and that the effects of metrazol, insulin and electric-shock treatments may be partly due to the fact that they increase the carbon dioxide content of the brain and blood.

At altitudes above 35,000 feet the arterial saturation with oxygen falls rapidly, with associated symptoms of anoxemia, in spite of breathing pure oxygen. There has been considerable discussion whether the addition of carbon dioxide to the inspired air physiologically increases altitude tolerance in the aviator. Theoretically this is possible on the basis of its ability to increase the dissociation of oxyhemoglobin, to cause cerebral vasodilatation and to stimulate respiratory activity. Gibbs et al.[67] made a study of arterial and jugular blood and of brain function in 8 normal men who breathed mixtures containing low percentages of oxygen and varying ratios of nitrogen and carbon dioxide. The addition of carbon dioxide to low-oxygen mixtures permitted maximal utilization of the available oxygen and the maintenance of normal brain function as seen in the electroencephalogram. Johnson et al.[68] studied the effects in dogs of adding carbon dioxide to oxygen-enriched atmospheres in low-pressure chambers. The addition of carbon dioxide corresponding to a tension of 14.3 mm. of mercury increased the minute ventilation by 39 per cent without any beneficial influence on the oxygen tension of the mixed venous blood. The authors concluded that such an added burden should be avoided in human beings when no benefit from carbon dioxide inhalations can be demonstrated.

### Water-Vapor Therapy

The principal value of water-vapor therapy is in the treatment of respiratory disease in which thick or tenacious mucopurulent secretions accumulate in the tracheobronchial tree and larynx. Thinner secretions may result from the high humidity of the inspired air, which reduces the loss of water from the mucosa, and expectoration is thus facilitated. Such therapy may be of life-saving value in croup, obstructive dyspneas and inhalation gas poisoning. Everyone is acquainted with the ancient steam kettle and the assortment of croup tents. More modern methods comprise the high-humidity room, humidified mask therapy and the humidified oxygen tent. The minimal allowable relative humidity is 75 per cent. This may be raised to the saturation point in the high-humidity room.[69] The Walton mechanical humidifier is an instrument that blows water vapor and fine droplets into the air by a fan and centrifugal force. No heat is evolved.

Holinger,[70] in discussing the therapy of acute laryngotracheal bronchitis, favors placing the patient in a room supersaturated with warm water vapor, the relative humidity reaching 90 per cent if possible. He also mentions briefly the use of oxygen, helium-and-oxygen mixtures, bronchoscopy, tracheotomy and the sulfonamides. No precise technic is described. His results appear good, but more data are necessary for proper evaluation.

It is doubtful whether tincture of benzoin employed in the simple steam humidifiers is of any value. Many believe it to be irritating. Following the suggestion of Healey,[71] I have employed a mixture of menthol, camphor and eucalyptol in a milk-of-magnesia base. Such a mixture was objectively comfortable in a group of patients with inhalation gas poisoning and obstructive respiratory disease.[72]

In employing oxygen therapy it is essential to ensure adequate water vapor. If one uses the catheter method, it is well to employ a simple water-bottle humidifier. Many prefer a diffusion-head inlet and a water-trap outlet type of humidifier. With the B.L.B. apparatus humidification may be desirable if high oxygen flows are used. Adequate water-vapor concentrations can be obtained with the use of the injector when employing the Barach–Eckman–Molomut mask. If higher humidity is desired, the injector may be removed and the water-bottle type of humidifier substituted. In using the oxygen tent it is difficult to maintain high humidity because the cooling system reduces the humidity. A moderate increase in humidity may be obtained by decreasing the temperature and increasing the circulation to maintain cooling. Davison[73] devised a method of connecting a Walton or Gilbert humidifier to the tent canopy, which is most effective, although not sparkproof. A sparkproof humidifier must be employed for use in high oxygen concentrations. This type of arrangement will probably be standard in the tent of the future.

### Administration of Vaporized Solutions

#### *Bronchodilator and Vasoconstrictor Drugs*

To the growing list of directive terms must be added the term "pulmonary route." Richards,

Barach and Cromwell[74] described the technic and value of employing continuous vaporization of epinephrine and other bronchodilator and vasoconstrictor drugs. They used mixtures of Vaponefrin or 1:100 epinephrine, with or without 1 per cent Neo-Synephrin. The solution was placed in the nebulizer and a flow of 4000 to 6000 cc. of oxygen per minute was passed through it from a pressure tank. The patient simply held the nozzle of the vaporizer in his mouth and breathed quietly. This therapy was repeated every three or four hours and generally took five to fifteen minutes to complete. Clinical improvement was at times striking. The vital capacity and maximum breathing capacity increased in the majority of patients with bronchial asthma, emphysema and acute bronchiolitis. Some cases of atypical (virus) pneumonia were treated in a similar manner. The velocity of air movement in inspiration and especially in expiration was increased with such therapy. Compressed air may be used in place of oxygen to nebulize these solutions.

I[18, 72] employed this method of therapy and found it of tremendous value in various types of serious respiratory disease, particularly those accompanied by bronchospasm, sticky tenacious sputum or a troublesome, unproductive hacking cough. Mixtures of 1:100 epinephrine and 1 per cent Neo-Synephrin, or Vaponefrin along with the latter, were employed. More recently, I found a mixture of 3.33 per cent Neo-Synephrin and 0.33 per cent epinephrine to be quicker acting but not so effective. One seldom encounters side reactions. The patient should rinse his mouth thoroughly after each treatment. Rarely one encounters an asthmatic patient who no longer reacts to epinephrine inhalation but responds to some extent to Neo-Synephrin alone. This therapy does away with the need for hypodermic adrenalin. Frequently these patients complain of headaches, tachycardia and vasomotor symptoms when given hypodermic adrenalin.

There are various types of nebulizers on the market. Following the suggestion of Barach, I have found the Vaponefrin model* most useful. It produces a fine, voluminous spray or "smoke screen." I have recently been supplied with a plastic model† that has the advantage of not being easily broken and of having greater portability.

Lockey[75] modified the approach of Richards, Barach and Cromwell[74] by adding 5 per cent glycerin to the 1:100 epinephrine solution. He describes the use of the method with a hand-bulb vaporizer, as well as by direct connection with an 80-gallon tank of oxygen. Irritation and dryness of the throat occurred less frequently with the use of 5 per cent glycerinized epinephrine than when epinephrine alone was employed.

The use of various therapeutic agents by continuous-vaporization therapy with oxygen or compressed-air streams is in its infancy. Barach[76–79] and his associates employed various bronchodilator and vasoconstrictor drugs and promin in both experimental and human pulmonary tuberculosis.

*Manufactured by the Vaponefrin Company, Upper Darby, Pennsylvania.

†Manufactured by Frederick Stearns and Company, Detroit, Michigan.

### *Sulfonamides*

The use of various chemotherapeutic agents in the fashion described above for the prophylaxis and treatment of upper respiratory infection has been reported with some enthusiasm. Negligible blood levels of the sulfonamides are generally obtained with this type of therapy. The blood concentration is due to absorption from the lung rather than from the stomach. Furthermore, Castex, Capdehourat and Pedace[80] demonstrated that nebulized solutions penetrate to the depth of the lungs. Confirming these observations, Krueger et al.[81] demonstrated on monkeys and mice with India ink and with radioactive chromic phosphate as indicators that, with inhalation, the material was uniformly distributed and penetrated to the outermost air sacs of the lungs at the ends of the bronchial tree. It thus seems possible that high local concentrations of a drug may be obtained in the absence of high blood levels.

The value of using solutions showing bactericidal or bacteriostatic activity for intrabronchial instillation or lavage has been described in earlier papers by Kolmer,[82] Stitt,[83] Moore[84] and others. These represent an early approach to inhalation therapy. Reports of the employment of the sulfonamides in pulmonary suppurative diseases with more modern technic have appeared more recently.

Castex, Capdehourat and Lavarello[85] report several cases of bronchopulmonary suppuration in which 3 to 5 cc. of 5 per cent aqueous sulfanilamide solutions was sprayed through a mouthpiece every four hours for about three months. They observed marked clinical improvement with this form of therapy, whereas oral sulfanilamide had not been successful. No ill effects were observed. They believe that local sulfonamide therapy attenuates the virulence of the bacteria, preventing a spread of the local infection to neighboring tissues and stimulating organic defenses against the infection.

Recently Chambers and his associates[86] developed a method for producing neutral-reacting aqueous sulfonamide preparations. They prepared minute microcrystals of these drugs that form a stable aqueous suspension. This preparation can then be used for vaporization therapy.

Harris, Sommer and Chapple[87] used a 5 per cent aqueous suspension of sulfathiazole microcrystals in an atomizer supplied with compressed air. The resultant spray ultimately formed a fine smoke. They employed this therapy in a group of mice and guinea pigs. No general ill effects or gross pulmonary changes were seen to result. They demonstrated that significant amounts of sulfathiazole can be directly absorbed from the lungs, thus producing high blood levels. They further demon-

strated that inhalation of sulfathiazole smoke can strikingly reduce the mortality of secondary pneumonia induced by a state of decreased resistance to the pneumococcus. They have been unable to show the qualitative superiority of the pulmonary over the oral route from a purely therapeutic viewpoint. They have suggested its possible prophylactic value.

Norris[88] recently reported satisfactory results in the management of 10 cases of acquired bronchiectasis with combined oral sulfonamide and bronchoscopic treatment. When given orally the concentration of sulfadiazine in the bronchial secretions was about 80 per cent of the blood level. A total of eighteen intratracheal or intrabronchial instillations of a 5 per cent suspension of microcrystalline sulfathiazole or a 2.5 per cent aqueous solution of sulfadiazine were performed. Specimens of bronchial secretions were obtained by bronchoscopic aspiration at twenty-four-hour intervals and the sulfonamide concentrations were determined. In none of the cases following instillation of sulfadiazine solution were there significant amounts of sulfadiazine at the end of twenty-four hours. Inasmuch as an aqueous solution was used, it was presumably more rapidly eliminated by absorption or expectoration. The levels with the sulfathiazole suspension, however, varied inversely with the average daily volume of sputum. From his observations Norris concluded that the combined use of oral sulfonamide and bronchoscopic aspiration has a definite value as a preliminary to lobectomy or pneumonectomy for suppurative disease and is also worthy of trial in nonsurgical bronchiectasis.

A recent report by Stacey[89] confirms the therapeutic efficacy of nebulized sulfathiazole solutions in patients with bronchiectasis. He employed 5 per cent solutions of sodium sulfathiazole in a small series and found improvement rapid, dramatic and without local or systemic reactions.

On the basis of the above reports with sulfonamide inhalation in suppurative pulmonary disease, it seems likely that this method of therapy will prove to be useful. By employing the technic of nebulization with oxygen flows described earlier, along with a microcrystalline sulfathiazole suspension, it is possible to distribute the material fairly uniformly and diffusely and in a sufficient quantity for continuous local effects. Furthermore, the viscosity of the secretions may be decreased by the simultaneous use of oral iodides. Addition of iodine to the sulfathiazole solution as an oxidizing agent may also help to destroy the inhibitory effects[88, 90] of para-aminobenzoic acid present in purulent exudates. Further investigations are necessary to evolve a more definite technic.

*Immune Serums*

Krueger et al[81] recently observed that mice given inhalations of a globulin fraction of anti-influenza horse serum were protected against influenza, the degree of protection increasing with the duration of inhalation. Treatment was effective as long as forty-eight hours after the mice contracted influenza. Repeated treatments twenty-four hours apart were significantly more effective than was one treatment. These authors believe that inhalation is a better method of giving the protective and remedial immune serum than is dropping it into the nose. They are making further studies of this method.

A possible hazard of this experimental procedure has been recorded by Hopps and Moulton.[91] They exposed guinea pigs and rabbits in closed chambers to finely atomized particles of various serums, and observed mild, severe and fatal allergic reactions. They caution against this procedure for the prevention and treatment of influenza in human beings.

*Other Drugs*

Propylene glycol vapor[92] has been found to be bactericidal in minute concentrations in the air. The molecules of the glycol, striking the small bacteria-containing droplet, quickly build up a concentration of glycol of 60 to 80 per cent within the droplet. To produce such a concentration of propylene glycol on the surface of the respiratory mucosa would require much more glycol than could be delivered by breathing a fog of this substance through a most effective vaporizer. It is therefore hardly possible that the use of propylene glycol vapor will be efficacious in the treatment of respiratory-tract infection.

Other therapeutic agents, however, will probably prove to be of value when administered by the pulmonary route. Perhaps in the future reports on the use of various hormones, vitamins and sulfonamides and of penicillin and other therapeutic agents will stimulate studies in this fascinating and growing field.

## Oxygen Therapy

The use of oxygen for the treatment of various types of anoxia has increased tremendously during the past two and a half decades. Tissue cells have no reserve supply of oxygen and hence must be continuously supplied with it by the circulation. Reviews of the physiologic principles on which oxygen therapy is based have been made by Haldane and Priestley,[93] Lundsgaard and Van Slyke,[94] Peters and Van Slyke,[95] Barcroft,[96, 97] Meakins and Davies[98] and others. Reviews of its therapeutic application have been made by Boothby and his associates,[1, 2, 4, 13, 99–102] Barach and his associates[54, 103–110] and others. An excellent outline of the physiology of respiration and the significance and treatment of anoxia in surgery may be found in a paper by Chase.[111] Employing a keen nautical imagination, the latter discusses the transportation

system in terms of cargo, crew and ships, the oxygen diffusion gradient from the lungs to the tissue cells being represented by the flow of water from the Great Lakes to the sea.

*General Clinical Use*

It is of interest at this point to recall that Beddoes in 1795 was enthusiastic about oxygen as a universal panacea. Gradually, however, its use became discredited owing to lack of effective administration and understanding of the principles underlying its use. The employment of 40 to 50 per cent concentrations of oxygen in the treatment of war-gas poisoning and the resultant pulmonary edema again stimulated the application of oxygen therapy to clinical disease.

Various concentrations of oxygen have been successfully employed in pneumonia, pulmonary atelectasis, pulmonary fibrosis, emphysema, bronchial asthma, pulmonary embolism, pulmonary edema of varied etiology, asphyxia and resuscitation, anesthesia, altitude and compression work, circulatory failure, angina pectoris,[112] coronary thrombosis,[113–115] anemias, abdominal distention,[1, 116–118] peritonitis, anaerobic infections[101] and migraine headaches[119]; following encephalography[1, 120]; during fever therapy[121]; for peripheral vascular disease, shock of all origin and severe burns; preoperatively and postoperatively; in neurosurgery, obstetrics and traumatic and military surgery; and for a variety of miscellaneous diseases. Reviews of the value of oxygen inhalations in the therapy of cardiorespiratory disease may be found in reports by Barach.[54, 103, 104, 107, 110] Reviews of the general use of oxygen therapy are given in the reports by Boothby and his associates.[4, 13]

It is generally appreciated that the onset of anoxemia in a normal person occurs at an altitude of 10,000 to 11,000 feet. At such altitudes oxygen must be supplied. At altitudes above 30,000 feet the effect of lowered barometric pressure is added to that of oxygen want. This results in aeroembolism or aeroemphysema. This is essentially the same as the so-called "bends," or caisson disease, and the air emboli may lodge in any of the blood vessels of the brain, coronary vessels or other terminal vessels. The emboli are nitrogen bubbles released at low pressures, and nitrogen can be partially replaced by oxygen. Preflight oxygen breathing and the same continued throughout ascent and descent prevents these reactions. Flying per se has no effect on the cardiovascular system. The effects noted — electrocardiographic changes and so forth — are all due to the low oxygen or low barometric pressure at high altitudes and the mechanical effects of speed. The latter result from centrifugal force, and the pilot "sees black" in positive accelerations — cerebral anemia and splanchnic and extremity engorgement — and "sees red" in negative accelerations. Mechanical devices may prevent or cure the latter, and oxygen the former.

Lovelace[122] in a timely discussion stresses the fact that any clinical condition that causes anoxia is poorly tolerated at high altitudes. He describes the need for adequate oxygen and the difficulty of providing it in cases of concussion of the brain with and without skull fracture, in anemias and fulminating infections and in patients receiving sulfonamide drugs. He stresses the danger of expansion of gas in patients undergoing pneumothorax and in those with penetrating abdominal lesions at high altitudes, due to the lowered atmospheric pressure. In the latter cases the advisability of abdominal decompression with Wangensteen suction is suggested.

It is not enough to administer oxygen of the proper concentration to the anoxic patient. The entire transportation system must be analyzed and the deficiency corrected. Removal and treatment of the cause, supplemental shock therapy and restoration of blood plasma and hemoglobin may be just as important.

*High Concentrations*

*Toxicity.* Considerable controversy still exists as to the effects of high concentrations of oxygen on the epithelium of the lung. The earlier observations in animal experimentations demonstrated specific untoward effects generally characterized by pulmonary irritation, convulsions and a decreased metabolism (Barach,[123] Binger, Faulkner and Moore,[124] Smith et al.,[125] Shilling and Adams,[126] Behnke et al.[127] and Campbell[128, 129]). It is now generally realized, however, that animals are more susceptible to oxygen poisoning than are human beings. Symptoms of oxygen toxicity were reported in normal persons rather than in patients with severe anoxia.

Occasional reports on toxicity in normal and sick persons appeared in the recent literature. Behnke and his associates[130, 131] observed impairment of neuromuscular control and convulsions in normal subjects exposed to pure oxygen at 1 atmosphere of pressure for longer than six hours. Becker-Freyseng and Clamann[132] made observations on 2 normal subjects who spent sixty-five hours in a gas-tight room containing 90 per cent oxygen. On the second day both felt uncomfortable, and in one there was a decrease in the vital capacity, associated with fever and a rapid pulse. On the third day one man felt especially ill and suffered from dyspnea, with a continuous fall in vital capacity. Behnke[131] found that inhalation of 100 per cent oxygen to normal human subjects for seven hours produced substernal soreness and toxic effects. Moody and Howard[133] report a probable case of oxygen poisoning occurring in a two-year-old child acutely ill with lobar pneumonia. During one of her periods in the tent the patient developed convulsions, which subsided when

she was removed from the tent and returned shortly after she re-entered it. She was kept in the tent at frequent intervals for a period of six days. Unfortunately, no mention is made of exact oxygen-percentage determinations. It appears difficult to classify this case as one of oxygen poisoning.

Behnke[131] stated that at atmospheric pressure pure oxygen is usually well tolerated by healthy persons over a period of six hours. An occasional healthy subject is particularly sensitive to it. The toxic signs and symptoms that may be observed at the higher atmospheric pressures are pallor, sweating, nausea, fatigue and irritability. These can be avoided by helium-oxygen breathing. Behnke and Yarbrough[134] observed that at a depth of 500 feet, corresponding to a pressure of 16 atmospheres, a diver breathing a mixture of 80 per cent helium and 20 per cent oxygen felt nearly as well as at atmospheric pressure. In Behnke's experiments healthy subjects breathed pure oxygen at a pressure of 2½ atmospheres for three hours without demonstrable harmful effects.

Although the cause of oxygen poisoning is unknown, Shaw, Behnke and Messer[29] demonstrated the remarkable relation between oxygen and carbon dioxide at increased atmospheric pressures. They showed in dogs at a constant pressure of 4 atmospheres that increasing the alveolar carbon dioxide tension was equivalent to raising the oxygen tension to about 5 atmospheres. When the carbon dioxide tension was lowered by hyperventilation, the oxygen tension was decreased to about 3 atmospheres. At this high pressure the addition of carbon dioxide served to increase the toxicity of oxygen, whereas lowering the alveolar carbon dioxide tension by hyperventilation delayed or even prevented the onset of toxic oxygen symptoms.

Armstrong[135] further demonstrated the safety of high concentrations of oxygen in his studies on rabbits at decreased barometric pressures. With pure oxygen at a tension of 350 mm. of mercury — equivalent to an altitude of 20,000 feet — he failed to produce lung injury after an exposure of two hundred hours. This result has been repeatedly substantiated in aviators in more recent years.

Continuing their extensive studies on the effects of drugs on anoxia, Emerson and Van Liere[136] evolved a standard test to study the effects of drugs on the tolerance to anoxia in mice. They observed a slight increased tolerance to anoxia in mice pretreated with exposure to pure oxygen or to helium-and-oxygen mixtures. They did not, however, consider the mortality reduction in the control animals sufficient to conclude that the lethal effects of anoxia can be minimized with pretreatment inhalation of oxygen and helium-and-oxygen mixtures. They believed that their results could not be considered applicable to therapy in man without further investigation.

*Clinical value.* Under normal conditions increased concentration of oxygen has no effect on tissue function. Boothby and his associates[4, 101, 102] demonstrated its value in the clinical anoxias. Inhalation of 70 to 100 per cent concentrations increases the partial pressure of oxygen in the lung, making it possible for the blood to absorb and transport a quantity in excess of the normal. The hemoglobin saturation can be raised from 96 to practically 100 per cent, and the oxygen in simple solution in the plasma from 0.3 cc. per 100 cc. of blood to a maximum of 2.2 cc. This represents a possible increase to as high as 15 per cent — supersaturation level — in the oxygen-carrying capacity of the blood throughout the circulatory system. This in turn produces a corresponding increase in the partial pressure available for the diffusion of oxygen from the blood into the tissues. In this connection, it will be recalled that Campbell and Poulton[62, 137] demonstrated that the oxygen pressure in tissue is increased proportionately more than is the increase in oxygen content of the blood.

Evans[138] has for many years repeatedly described beneficial clinical results from so-called "100 per cent" oxygen in severe anoxia. Concentrations of 70 to 100 per cent should be used when lower concentrations are unsatisfactory. Boothby and his associates[4, 13, 101] in extensive clinical observations proved the safety of high concentrations if used properly. They administered 90 to 100 per cent concentrations to approximately 800 patients for periods as long as forty-eight hours without any evidence of pulmonary irritation. They warned against continued administration for longer than forty-eight hours. Further clinical evidence showed that high concentrations can be used with safety with a mask apparatus for periods of two to five days. It is well to remember that mask therapy is really not continuous, inasmuch as the patient talks, eats or has the mask removed frequently for general nursing care.

In a recent paper Reinhard, Moore, Dubach and Wade[139] report on the effect of breathing 80 to 100 per cent oxygen in patients with sickle-cell anemia. They observed 3 patients at six different times, using the B.L.B. apparatus, with pure-oxygen flows without intermission for periods of eight to twenty days. They state: "No distinct toxic manifestations of the oxygen administration were noted except for inflammation and congestion of the mucous membranes of the upper respiratory passages. After oxygen was discontinued, 2 of the 3 patients became nauseated and had headache for twenty-four to forty-eight hours." My own clinical observations for periods of three to five days in patients with serious respiratory disease led to similar conclusions.

In closed respiratory chambers, such as the helium-and-oxygen hood apparatus, Barach[9, 140] considers it inadvisable to use continuous oxygen

concentrations of above 70 per cent for more than forty-eight hours. If longer periods must be continued, he suggests allowing the entrance of room air for half an hour every three or four hours. He[78] reports a case of continuous residence for six days without toxic effects, but the oxygen concentration was left below 70 per cent.

Oxygen toxicity from high concentrations can occur in anoxic patients; however, whenever indicated, high concentrations can be given safely for periods as long as one week with mask therapy, and intermittently for as long as this with hood therapy.

*(To be concluded)*

## References


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# CASE RECORDS OF THE MASSACHUSETTS GENERAL HOSPITAL

## Weekly Clinicopathological Exercises

FOUNDED BY RICHARD C. CABOT

TRACY B. MALLORY, M.D., *Editor**

BENJAMIN CASTLEMAN, M.D., *Acting Editor*

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## CASE 30151

### PRESENTATION OF CASE

*First admission.* A fifty-year-old man entered the hospital because of a draining abdominal sinus.

The patient had been in apparent good health until about ten months before entry, when he developed generalized abdominal discomfort, most marked in the lower midline. This was accompanied by tenesmus, but an attempt to move the bowels was unsuccessful. He became slightly distended, but had no nausea or vomiting. He was operated on the second day of the illness. The details of the examination and operative findings were unknown, except that a lower right paramedian incision was made and a drain was left in place. This drained feces for four weeks and continued to do so, although in a much reduced volume. Postoperatively he had normal bowel movements by rectum with the aid of 30 cc. of mineral oil daily. He had had no distention, pain, or bloody, tarry or mucous stools. His appetite had been poor. He had lost 20 pounds during hospitalization, but his weight had remained constant since.

He had had typhoid fever two years before admission, was hospitalized for several weeks, but recovered without any sequelae.

Physical examination revealed a well-developed, moderately well-nourished man, with evidence of recent weight loss. The heart and lungs were negative. The abdomen was soft and nontender. There was a small draining sinus in the midportion of an otherwise well-healed, low, right paramedian incision.

The blood pressure was 120 systolic, 80 diastolic. The temperature, pulse and respirations were normal.

Examination of the blood showed a red-cell count of 4,920,000, with 14.9 gm. of hemoglobin. The white-cell count was 8800. The urine was negative. Stools were guaiac negative. A blood Hinton test was negative.

A barium enema passed without delay from the rectum to the cecum. The sigmoid was spastic, and several diverticulums were visible in the distal sigmoid. The mucosa was swollen. Postevacuation films showed the sigmoid to be markedly irregular, with a projection that was thought to be a fistulous tract. The remainder of the colon was contracted on the postevacuation film and displayed normal mucosal relief, except the ascending colon, which contained no barium. Re-examination of the colon showed marked irregularity of the wall of the sigmoid just above the rectosigmoid junction. There was no filling of the fistulous tract by enema. The cecum and ascending colon were spastic but filled symmetrically without filling defects. A lipiodol injection of the sinus tract showed ready passage of the dye to what appeared to be the sigmoid.

On the sixth hospital day a transverse colostomy was performed. Postoperatively the patient did well. The colostomy appeared to function well. On the third postoperative day he had a severe cramplike epigastric pain. Six hours later he vomited greenish, bitter material, and the vomiting persisted. The pain became intermittent. The abdomen was not distended, and peristalsis was normal. There were no masses or tenderness.

Plain films of the abdomen showed no dilated loops of bowel, but there was some gas scattered through the colon. At the level of the second lumbar interspace, there was a small round area of gas, which was thought to be in the small intestine. Just above this a rounded area of increased density measuring 3.4 cm. was seen. This had a rather smooth margin.

A Miller–Abbott tube was passed. He had a good bowel movement through the colostomy opening, with complete relief of symptoms. The Miller-Abbott tube was removed, and he was discharged home to return for another operation.

*Second admission* (twenty-four days later). Following discharge the patient had a bout of diarrhea lasting two or three days but was otherwise asymptomatic. His weight had remained essentially the same.

Physical examination was as before.

Examination of the blood showed a hemoglobin of 13.6 gm.

On the third hospital day an operation was performed.

### DIFFERENTIAL DIAGNOSIS

DR. CARROLL C. MILLER: When the patient was admitted for the first time, he presented at first glance a perfectly definite and typical picture. If it were not for two complicating details, — namely, the gastrointestinal upset following the first operation and the visualization of a peculiar mass in the abdomen following this episode, either or both of which may or may not have anything to do with the final diagnosis, — it would be relatively easy to predict what was found at the second operation and the patient's subsequent course.

*On leave of absence.

Let us, at the start, discuss the more likely underlying diagnosis. We see in the report and on the films that there was definite diverticulosis and probably diverticulitis of the sigmoid. When the patient first became ill, he complained of low abdominal pain, together with bowel tenesmus, difficult defecation and abdominal distention, but no nausea or vomiting. All these details are perfectly consistent with a diagnosis of diverticulitis in a middle-aged man. One aspect of the picture is slightly unusual. The onset was apparently abrupt, without premonitory signs of a disturbance in the lower bowel. People with diverticulitis frequently complain of difficulty in moving their bowels, tenesmus and, occasionally, the passage of small amounts of blood over a period of some months or years. It is quite conceivable, however, that a bland type of diverticulosis may exist up until the time when a combination of physical circumstances arises to block off a diverticulum, seal up an infection in it and initiate an inflammatory process that may spread to involve bowel wall and structures around the bowel. All that can occur in the course of a few hours, presenting a picture that simulates a combination of low intestinal obstruction and peritonitis. This is apparently what the first operator thought when he made his first incision. The possibility of acute appendicitis should not have been given much consideration because of the location of the most marked pain and the absence of nausea and vomiting. No mention is made of previous symptoms that could be attributed to a chronic cholecystitis or cholelithiasis and that might contribute to the diagnosis we are attempting to establish.

We have, therefore, a man who, on first admission to this hospital, presented a story and completely satisfactory x-ray evidence of a subsided inflammatory reaction in the lower abdomen or pelvis, with the establishment of a fecal fistula communicating with the sigmoid. In the x-ray films the presence of diverticulums, the spasm and the irregularity of the wall of the sigmoid substantiate such a diagnosis. The surgeon who performed the first operation in this hospital evidently felt the same way and rightly performed a transverse colostomy in preparation for a subsequent exploration, with a view to extirpating the fistula and removing the diseased bowel.

The intestinal complication occurring on the third postoperative day may have been due to an inflammatory reaction around the site of the transverse colostomy, causing a subacute intestinal obstruction. At that time the second complicating and disturbing element entered the picture—namely, the curious rounded mass seen in the flat abdominal film. This mass apparently was not visible in any of the previous films. It may have been obscured by some other denser structure and at that particular moment may have become obvious. I am sure that I cannot guess what it was. One would like to postulate a gallstone that had eroded from the gall bladder into the small intestine and caused intestinal obstruction, but this mass was unusually large and it is unlikely that such a gallstone would cause no further trouble. A gallstone of such size would undoubtedly have great difficulty in passing the ileocecal valve and therefore would cause further obstruction, which the patient did not have. We are not told and cannot be sure where the mass lay in relation to the lumen of the bowel. It is conceivable that this was a scybalum of barium lasting over from the previous barium enema, but its density in the x-ray film does not appear to be that of residual barium. Consequently, although I am much perplexed by the appearance of this phenomenon, I cannot believe that it had anything directly to do with the patient's subsequent condition.

When the patient re-entered this hospital he was apparently in good condition and ready for the operation that had been planned. I am a little surprised that it was done so soon after the first, for I should suspect that insufficient time had elapsed to allow the inflamed sigmoid to become suitable for surgery. I should suppose that there was still induration with adhesions in the lower abdomen and pelvis, making exploration and resection difficult. My final diagnosis is diverticulitis of the sigmoid, with fecal fistula.

### Clinical Diagnosis

Diverticulitis of sigmoid, with sinus tract.

### Dr. Miller's Diagnosis

Diverticulitis of sigmoid, with fecal fistula.

### Anatomical Diagnoses

Diverticulitis of sigmoid, with perforation.
Peritonitis, acute and chronic, localized, with matting of loops of small intestine.
Diverticulosis of sigmoid.
Meckel's diverticulum.

### Pathological Discussion

Dr. Benjamin Castleman: At operation Dr. Arthur W. Allen found many coils of matted small intestine adherent to the anterior abdominal wall at a point midway between the symphysis and the umbilicus, just to the right of the midline. The sigmoid was completely collapsed and was drawn over into this mass of matted small bowel, which corresponded to the site of the fistula. When these loops were dissected free it was found that a Meckel's diverticulum, measuring 6 cm., was in the center of the mass. About 50 cm. of ileum, including the diverticulum, was resected, and a side-to-side anastomosis was performed. Then the sigmoid was resected with an end-to-end anastomosis.

When we received the specimen there were two small perforations of the ileum about 4 cm. from the

Meckel's diverticulum. These could have been made in dissecting away the adhesions or may have been produced by the localized peritonitis in the region of the fistula. The Meckel's diverticulum showed no evidence of intrinsic inflammation. The sigmoid, however, was markedly thickened and covered with a patch of fibrinous exudate, in the center of which was a small perforation 2 mm. in diameter that connected with a long diverticulum. This diverticulum was inflamed, and appeared to be the primary source of infection. In addition there were many noninflamed diverticulums throughout the specimen.

Three weeks later the original colostomy opening was closed; the ends of the colon were resected, and an open end-to-end anastomosis was performed.

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## CASE 30152

### Presentation of Case

A seventy-nine-year-old retired factory manager entered the hospital because of persistent cough.

The patient had been in excellent health until six months before admission, when without antecedent upper respiratory infection he developed a paroxysmal cough productive of a small amount of thick, nonodorous, greenish sputum. This persisted until about six weeks before admission, when the amount of sputum increased to several tablespoonfuls daily. He developed a "smoky feeling" under the sternum at the level of the sixth rib, without definite pain. He had had no hemoptysis, chills, fever or weight loss. An x-ray film of the chest, taken two weeks before entry showed slight enlargement of the heart downward and to the left. The lower part of the right lung field was less radiant than normal. In the lateral view the outline of the middle lobe was easily seen, and its position corresponded to the area of fullness in the right lower chest. The interlobar septums were moderately thickened. The lung fields were otherwise clear.

The patient had been extremely active until six years before the onset of his present illness, when he was advised by his physician to "take it easy." Two or three years later he noticed shortness of breath on climbing two flights of stairs.

Physical examination showed a well-developed, well-nourished man. He was distressed by frequent cough. The trachea was in the midline. There was dullness posteriorly over the right clavicle. The breath sounds were increased and well transmitted. Many moist inspiratory and expiratory rales were heard over the right middle and upper lung fields. There was a loud moist wheeze over the whole right lower chest. The heart was slightly enlarged; the sounds were regular but faint. Examination was otherwise negative.

The blood pressure was 158 systolic, 88 diastolic. The temperature was 99.4°F., the pulse 85, and the respirations 24.

Examination of the blood showed a hemoglobin of 14.9 gm. The white-cell count was 6800, with 64 per cent neutrophils. The urine was normal. A blood Hinton test was negative. Another x-ray film of the chest, taken two weeks after the previous examination, revealed some increase in the size and density of the lesion on the right. There was no respiratory movement of the right half of the diaphragm. The outline of the diaphragm was irregular, and the right costophrenic sinus was shallow. The pleura was somewhat thickened along the axillary border.

On the third hospital day a bronchoscopy was performed.

### Differential Diagnosis

Dr. Helen Pittman: May we see the x-ray films?

Dr. Milford Schulz: The right middle lobe does not seem to me to be particularly decreased in size. I believe this represents its outline. There is hazy increased density overlying the right lower chest.

Dr. Pittman: What about the pleural thickening?

Dr. Schulz: There is a little on the right, and I wonder if the increase in density on the right side as compared with that on the left might not all be due to the thickened pleura.

Dr. Pittman: What about the position of the diaphragm on the left?

Dr. Schulz: It is elevated. A true paresis of the left half of the diaphragm, which would have been noticed fluoroscopically, was not observed.

Dr. Pittman: There was true paresis on the right?

Dr. Schulz: That must be accepted as the fluoroscopist's observation.

Dr. Pittman: I do not believe that these films throw much light on the subject, and I am rather disappointed.

This seventy-nine-year-old man was in excellent health until the age of seventy-three, when he was advised to "take it easy." He had shortness of breath, which does not seem out of order for someone who is that old.

His illness began six months previously, when, without any prodromal symptoms and without any respiratory symptoms, he suddenly began to have paroxysmal cough and raised small amounts of sputum; this continued for a matter of four months or so. Then, for no apparent reason, the sputum increased in amount and became thick and yellowish and the patient developed a peculiar feeling, a "smoky" feeling, — whatever that means, — under the sternum at the level of the sixth rib. He did not have pain, did not spit blood and did not have chills, fever or weight loss. In other words, the only clue is that he had productive cough.

Physical examination showed dullness posteriorly on the right, over the right clavicle, which I suppose means the right apex posteriorly. "Breath sounds were increased and well transmitted." They usually are in that region of the chest. I do not believe that

that means so much. The loud moist wheeze over the right lower chest is the first thing that gives a localizing clue; the unilateral wheeze I interpret as a definite indication of partial obstruction of one bronchus on the right side — the middle or lower lobe, I do not know which. I should guess the middle lobe, but from the description and from these films I cannot be sure. He had slight fever, which seems noncontributory. He had no anemia and no leukocytosis, and the white count was normal, with a low normal percentage of neutrophils.

So we have here a man with a cough who had nothing to go with the cough and no evidence of infection beyond a temperature of 99.4°F. At no time had he had bleeding, pain, or anything that would lead one to suspect carcinoma, and of all the things that should make one suspect carcinoma, bleeding is the most significant. The absence of bleeding is important, but not necessarily diagnostic.

Then we come to the next positive finding, — the area of increased density in the right lower chest, — and I think that the only other definite positive finding is that there was no respiratory movement of the right half of the diaphragm. Why was there no respiratory movement of the diaphragm on the right? I do not know. We have nothing from the history, physical examination or x-ray findings to suggest that there was a process involving the phrenic nerve on that side. It is hard to think that he could have an aortic aneurysm involving the phrenic nerve with as little to go on as this.

The next point is, Did he have an acute pleurisy on the right side, which would cause immobility of the diaphragm? He had had no pain at any time, and the evidence of real pleurisy is extremely slim. I am sure that the immobility of the right leaf of the diaphragm is one of the most important findings, but there is not enough evidence to say with any certainty what caused it. So we are left with the area in the right lower chest. Whether these x-ray changes were secondary to the paralysis of the diaphragm, I do not know. I rather doubt it, because he was producing large amounts of sputum, and I am assuming that he had something in the bronchus causing partial obstruction, which was giving him this wheeze. We have no way of tying that up with the diaphragm unless we assume carcinoma, but there is no evidence on which one is justified in saying that this man had carcinoma.

How about a bronchial adenoma? I do not believe that we have enough evidence to postulate an adenoma, although that is one of the things that has to be seriously considered.

How about a nonopaque foreign body? It will cause a wheeze, but it is always associated with infection, and that is true everywhere else in the body. I do not see that we are justified in making that diagnosis.

Tuberculosis always has to be thought of, but again there is not much to go on. It is an unusual site for tuberculosis, although that does not rule it out. In a seventy-nine-year-old man I should certainly expect more evidence of old tuberculosis elsewhere in the chest than we have in this x-ray film.

Is there enough evidence of old pleural infection to think he could have had at some time empyema and a bronchial fistula? There is absolutely no evidence for that, and again if it were active enough to have suddenly broken into a bronchus, with the patient evacuating empyema fluid out through his mouth, I should expect signs of infection and not an odorless sputum, although that is possible.

So I am left with a series of entirely unsatisfactory explanations for this man's condition. Because he had definite physical signs on the right side, and because he did have a wheeze heard only on the right side, I am going to cling to something in the bronchus, causing partial obstruction, as the most probable lesion. And because I have no evidence that satisfies me for carcinoma or for tuberculosis, I am going to call it adenoma, but with little faith.

Dr. Edward B. Benedict: We did a bronchoscopy with a preliminary diagnosis of carcinoma, believing that in a patient of this age carcinoma was the most likely diagnosis. We did not pay enough attention to the fact that the patient had not lost any weight. Bronchoscopy showed widening and partial fixation of the carina, and a nodular outcropping in the right-stem bronchus causing partial obstruction of the right middle and lower lobes.

### Clinical Diagnosis

Carcinoma of the lung.

### Dr. Pittman's Diagnosis

Bronchial adenoma.

### Anatomical Diagnosis

Tuberculosis of the bronchus.

### Pathological Discussion

Dr. Benjamin Castleman: From the appearance that Dr. Benedict has just described it was thought that the diagnosis was probably carcinoma. The material that we received showed a granulomatous process, with one suggestive tubercle, although we did not have enough material to make a positive diagnosis of tuberculosis. It certainly looked suspicious of tuberculosis, however, and this was confirmed by examination of the sputum, which contained numerous tubercle bacilli. The patient therefore had tuberculous stenosis of the bronchus, probably with involvement of the mediastinal lymph nodes.

Dr. Benedict: I have tried to keep in touch with this patient, and from hearsay, I have learned that he is doing well. He is going to an osteopath.

Dr. Castleman: Are organisms still present in his sputum?

Dr. Benedict: I do not believe that his sputum has recently been examined.

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## PUBLIC OPINION AND COMPULSORY SICKNESS INSURANCE

The Wagner–Murray–Dingell Bill has provoked a great deal of discussion among physicians. Numerous editorials and articles have appeared in medical journals, and it is fair to assume that most doctors have thought somewhat about the significance of Title *IX* of the bill and know how most of their colleagues react to it. On the other hand, what other professional men and laymen think about the medical aspects of the bill is less clear. It is known that soon after the bill was introduced into Congress, the leaders of both national labor organizations issued statements strongly supporting it. Furthermore, editorials have appeared in the press both for and against this proposed legislation.

Some time ago the American Bar Association appointed a committee to study the medical provisions of the bill, and its report, which was reprinted in the March 11 issue of the *Journal of the American Medical Association*, is well worth reading. The preamble to its conclusion is as follows:

> The American Bar Association is limited to an expression of opinion and judgment with respect to those fields which relate to the administration of justice and which directly affect the safeguards and protection of the rights and liberties of the citizens of this country. Under normal circumstances, therefore, it is not the function of this association to attempt to influence substantive legislation by the Congress of the United States. But when, under the pretext of the general welfare, legislation is proposed in Congress which either inadvertently or with deliberate subtlety constitutes a direct attack on the rights and liberties of the citizens of this country, it becomes the duty of this association actively to voice its objections. . . .

It is apparent that the main objections of the committee are based on the powers vested in the Surgeon General of the United States Public Health Service, without machinery of appeal, and the vicious system of federal control, without safeguarding the rights of patients, hospitals and physicians.

Another important point of view is furnished by a comprehensive survey recently made for the National Physicians Committee and published in a booklet entitled *The American People*. This should be read and studied by every physician and should be passed along to his patients and friends. It is quite evident from this survey that the majority (84 per cent) of the people, including industrial workers, are unwilling to pay the cost of a federal health system, and that 68 per cent will have nothing to do with it regardless of cost. A significant fact to be gleaned from the survey, however, is that 63 per cent of the people *do* want some form of prepayment sickness insurance. This warning cannot be ignored.

The extraordinary success of the Blue Cross, both in Massachusetts and elsewhere, can leave no doubt in anyone's mind that voluntary organizations are able to provide adequate hospital care if they are well administered. Furthermore, it seems likely that voluntary insurance schemes for covering the costs of medical care will prove to be equally effective. Many such plans are already in operation, including

the Blue Shield, sponsored by the Massachusetts Medical Society, but at the moment they do not cover the needs of enough people. It is evident that the laity do not want compulsory health insurance sponsored by the Government: 85 per cent of the people believe that their physicians have a personal interest in them and that this would be lost under federal control. Nonmedical people are looking to the medical profession for leadership in providing complete prepayment sickness insurance on a voluntary basis.

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## FORT DEVENS CONFERENCE ON MILITARY SURGERY

The Conference on Military Surgery presented by the surgical staff of the Lovell General Hospital at Fort Devens on March 30 was attended by 46 medical officers of the United States Navy as well as by 127 civilian physicians from various parts of New England, the total attendance being 284. The conference was an outstanding success and clearly demonstrated the high grade of clinical and laboratory procedures used by the armed forces. The subjects of penicillin therapy and reconstruction of intestinal wounds and a motion picture study of the rehabilitation of the wounded soldier were of especial interest.

Such conferences are the complement of the monthly graduate courses presented by civilian instructors under the auspices of the New England Committee for Wartime Graduate Medical Meetings at twenty different stations of the Army and Navy throughout New England, beginning last November.

It is of further interest to know that both the Army and Navy plan to have exhibits at the annual meeting of the Massachusetts Medical Society in May. Details about these exhibits will be published in the final program.

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## MEDICAL EPONYM

### Sudeck's Atrophy

Dr. Paul Sudeck (b. 1866), professor of surgery at Hamburg, was the author of a paper, "Ueber die acute entzündliche Knochenatrophie [Concerning Acute Inflammatory Atrophy of Bone]," published in the *Archiv für klinische Chirurgie* (**62**:147-156, 1900). A portion of the translation follows:

> The . . . bone atrophy that occurs in association with acute inflammatory affections of the bones and joints occupies a special place in my opinion, and is essentially different from the simple atrophy of disuse. In the latter, for example, atrophy occurs to any considerable extent only if the functional stimulus has been lacking over a long period of time, — at least a few months, — whereas in what I have referred to as acute inflammatory affections of the bones and joints a significant degree of atrophy takes place in a remarkably short period of time, not only indeed in the bones directly involved, but also in the neighboring bony structures that are functionally related to the diseased bone.

R. W. B.

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## MASSACHUSETTS MEDICAL SOCIETY

### COMMITTEE ON LEGISLATION

Public hearings will be held in various cities of the Commonwealth to study the possibility and desirability of a system of cash payments to persons who become unemployed because of illness or accident not otherwise covered under the Workmen's Compensation Act.

The Massachusetts Legislature, by Chapter 54 of the Resolves of 1943, placed the responsibility of the study of such a program with the State Advisory Council of the Massachusetts Division of Employment Security. Public hearings, conducted by this body, are scheduled as follows:

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| Lawrence | April 17 | Council Chambers, City Hall<br>2:30 p.m. and 7:30 p.m. |
| Fall River | April 20 | Council Chambers, City Hall<br>2:30 p.m. |
| New Bedford | April 20 | Room 20, City Hall<br>7:30 p.m. |
| Springfield | April 26 | Room 212, City Hall<br>2:30 p.m. and 7:30 p.m. |
| Pittsfield | April 27 | Council Chambers, City Hall<br>2:30 p.m. and 7:30 p.m. |
| Worcester | April 28 | Council Chambers, City Hall<br>2:30 p.m. and 7:30 p.m. |
| Boston ..... | May 1 | Ford Hall, 15 Ashburton Place<br>2:30 p.m. and 7:30 p.m. |

The Advisory Council, through these hearings, is seeking to obtain the reactions of the people of Massachusetts as to the need of such a program. The following questions are pertinent: (1) Is there the need of a compulsory program of cash benefits for sickness or nonindustrial accidents in the Commonwealth of Massachusetts? (2) If such a program should be adopted, should it become a part of the present unemployment compensation program or is it in fact an inseparable part of a general health program which, if adopted, should be administered by some other department, such as the Department of Public Health? Is the country ready for a general health program? (3) If desirable to adopt a state system of sickness benefits, how should it be financed? Can the Massachusetts worker afford to pay for any further expansion of the social security program?

Should the system be financed by employee or worker contributions only? By employer contributions only? By a combination of both? Or by a combination of employer, employee and state contributions? (4) Is such a program of a social or public interest? If social, should not all the residents of the Commonwealth be included in the program instead of confining the same to workers covered under the present unemployment compensation program?

The above is an outline of the type of questions involved and to which the Advisory Council wishes to obtain an expression of opinion on the part of the general public prior to making its report to the General Court. The members of the State Advisory Council of the Massachusetts Division of Employment Security are Morris B. Lambie, chairman, Henry Cloutier, Joseph Cabral, Mary M. Riley, Fred W. Steele and Alfred E. Rankin.

All parties interested in this matter are cordially invited to attend.

BRAINARD F. CONLEY, *Chairman*

## DEATHS

COLBURN — Frederick W. Colburn, M.D., of Boston, died April 9. He was in his seventy-fourth year.

Dr. Colburn received his degree from the Boston University School of Medicine in 1897. In 1899 and 1900 he did postgraduate work at Vienna, Austria, and Halle, Germany. Shortly after his return to Boston, he became assistant instructor of otology at the Boston University School of Medicine. At the time of his death he was professor emeritus. He joined the staff of the Massachusetts Memorial Hospitals as assistant aural surgeon and later advanced to surgeon-in-chief of the Ear, Nose and Throat Department. He was a member of the Massachusetts Medical Society, the American Medical Association and the American Homeopathic Ophthalmological, Otological and Laryngological Society and a fellow of the American College of Surgeons.

A daughter, two sons and a brother survive.

GLEASON — Edward F. Gleason, M.D., of Boston, died April 9. He was in his seventy-sixth year.

Dr. Gleason received his degree from the University of Vermont College of Medicine in 1899. He studied surgery at the University of Vienna and on his return established practice in Boston. He was one of the first members of the staff at Cape Cod Hospital, Hyannis, which was founded in 1920. He was a member of the Massachusetts Medical Society and the American Medical Association.

His widow, two daughters and two sisters survive.

LEMAIRE — Willard W. Lemaire, M.D., of Worcester, died January 27. He was in his sixty-sixth year.

Dr. Lemaire received his degree from the University of Vermont College of Medicine in 1902. He was a member of the Massachusetts Medical Society and the American Medical Association.

His widow, a son and a daughter survive.

MERRICK — Francis H. Merrick, M.D., of Boston, died January 17. He was in his thirty-eighth year.

Dr. Merrick received his degree from Boston University School of Medicine in 1933. He served on the staffs of the Boston City and St. Elizabeth's hospitals. He was a member of the Massachusetts Medical Society and the American Medical Association.

PARKS — Silas H. Parks, M.D., of Great Barrington, died November 7. He was in his eighty-third year.

Dr. Parks received his degree from the Albany Medical College in 1885. He was a member of the Massachusetts Medical Society and the American Medical Association.

## MISCELLANY

### TUBERCULIN TEST, X-RAY AND OTHER DIAGNOSTIC AIDS

To diagnose the greatest possible percentage of unsuspected cases of tuberculosis, to place these people under immediate and adequate care, to render them and the community safe from further spread of their disease, to rehabilitate every patient into a productive member of society — these are our tasks. Diagnostic procedures that guarantee the maximum return in case finding are those that safely apply the clinical lessons of the past to the pressing problems of the present. No thorough clinician relies exclusively on a solitary diagnostic aid, even when circumstances strongly tempt him to do so. These points are clearly brought out in the following paper (Myers, J. A. Tuberculin test, x-ray and other diagnostic aids. *Journal-Lancet* April, 1944).

There is now a strong tendency to "diagnose" tuberculosis by short-cut and sometimes slipshod methods. Recently, a few physicians were asked how they would proceed to find all the tuberculosis among the population of an entire industry or county. One stated that increased red-cell sedimentation rate would ferret out all cases. Another would discover them by finding acid-fast bacilli in their sputums. Still another would employ only x-ray-film inspection of their chests. Other similar methods were offered. Each physician presented an important phase of an examination, but not one of them was adequate. To achieve a satisfactory diagnosis each one of this group of physicians would have to examine a given individual in his own way, then pool his findings with those of his colleagues — a wasteful and illogical procedure.

There can be no tuberculosis in the absence of tubercle bacilli; therefore, the first phase of an examination is to determine whether bacilli are present. This can be done by the tuberculin test, which is accurate and specific except in the first few weeks after infection occurs, and in acutely ill and terminal cases. Other failures are usually due to the use of impotent tuberculin or to improper administration. Under proper conditions, then, a nonreactor to tuberculin can be told that he does not have living tubercle bacilli in his body. On the other hand, a reactor has at least primary lesions that contain living tubercle bacilli. Exceptionally, and only when all bacilli die, allergy persists for a time, then wanes and disappears. Inasmuch as primary tuberculosis is a prerequisite for the clinical forms, it is of extreme importance to know whether it is present. The tuberculin test provides this information with uncanny accuracy. With the exceptions mentioned, it is with great rarity that the person with clinical tuberculosis fails to react to tuberculin.

The next phase of the examination consists of inspecting the chests of all adult reactors with the x-ray. On the ordinary film 25 per cent of the lung parenchyma is obstructed from view by shadows of such parts as the heart and diaphragm. Films fail to reveal evidence of primary tuberculosis in 70 to 80 per cent of the persons in whom it actually is present. So, too, many lesions of the reinfection type, because of their size and consistence, escape detection. It is a frequent experience to view a film that appears clear, yet one of the same chest a few months later reveals evidence of disease. Therefore, adult tuberculin reactors whose lungs appear normal should have films at least annually.

After tuberculous lesions of the reinfection type attain macroscopic proportions, x-ray inspection is by far the best method of detecting their locations when they are in that part of the lung which is visualized; indeed, they cast shadows on an average of two or three years before they cause significant symptoms. Final diagnoses, however, should never be made from x-ray shadows, since those cast by tuberculous lesions may be indistinguishable from those of numerous other pulmonary diseases, such as sarcoidosis, silicosis, malignant tumor, fungus infections, abscess and pneumonia. When a lesion is found, its etiology can usually be determined by other methods.

The present, widely used procedure that begins with x-ray inspection of the chests of large groups of adults is laudable, provided it does not end there. All concerned must be informed that x-ray inspection is done with the unaided eyes and reveals nothing but macroscopic lesions, that one fourth of the lung parenchyma is obstructed from view by shadows of other parts and that final diagnoses cannot be made with accuracy from x-ray shadows. Thus, the tuberculin test screens out those persons who have living tubercle bacilli in their bodies, and from them the x-ray screens out those who have gross lesions that may be tuberculous. Neither nor both procedures constitute an adequate examination.

To determine whether a demonstrable lesion is tuberculous one must seek tubercle bacilli in material obtained from it. Among patients with extensive tuberculous lesions these are usually promptly recovered from the sputum. When bacilli are not found in more than one of several specimens, or if no sputum is present, gastric lavage may reveal their presence. Visualizing acid-fast organisms by the aid of the microscope may not be sufficient because of laboratory errors and also because nonpathogenic, acid-fast bacilli are sometimes found in the sputum and gastric contents; therefore, their pathogenicity should be determined by culture on an artificial medium or by animal inoculation. In the event tubercle bacilli or other pathogenic organisms are not recovered, one should observe frequently new x-ray films to determine whether abnormal shadows persist or any significant changes occur in or around them. Among persons beyond thirty-five years, however, one should avoid delay; as the lesion may be malignant. In such cases the bronchoscopist should be consulted, as he may promptly reveal the etiology.

There is no more deplorable practice than to have tuberculin tests administered and x-ray films prepared, after which the physician makes diagnoses without seeing the subject and completing the examination. The subject should always be interviewed by the physician. Although most persons have no symptoms for an average of two or three years after the disease can be located, and practically none of those with primary tuberculosis give histories of significant illness, the tuberculin reactors whose chest films are entirely clear may relate symptoms caused by extrathoracic tuberculosis. Indeed, acute conditions, such as meningitis and miliary disease, or chronic lesions in such parts as the kidneys, pelvic organs, and bones and joints may be developing.

Following the interview, even though no significant evidence is obtained, the remainder of the traditional physical examination should be made, since significant pulmonary signs may be elicited from lesions located near the periphery or in parts of the lungs not visualized by x-ray; moreover, lesions may be found during the scrutiny of extrathoracic regions.

To summarize: Tuberculosis begins when the tubercle bacilli first enter the human body and are focalized in microscopic lesions. At that stage the disease may lie dormant or may even disappear. Again, it may undergo exacerbations and remissions resulting in every form of clinical tuberculosis to which the human body is heir. The physician can diagnose tuberculosis within a few weeks after the first invasion of tubercle bacilli, and he can detect most of the subsequent lesions with considerable promptness. Either to diagnose tuberculosis when it does not exist or to fail to find it when it is present, is inexcusable. Nearly all errors in diagnosis are due to short-cut or slipshod methods and may be avoided by employing every phase of a complete examination. — Reprinted from *Tuberculosis Abstracts* (April, 1944).

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## THE WHITE PAPER ON THE NATIONAL HEALTH SERVICE

The following statement was recently released by the Information Division, British Information Services, 30 Rockefeller Plaza, New York City.

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The White Paper on National Health Service published by the Ministry of Health and the Department of State for Scotland on February 17, 1944, is the latest in a series of far-reaching plans for the social development of Great Britain. Its aim is to fill the gaps in Britain's already extensive medical services and "to make a complete range of medical services of the best quality available to all."

The White Paper represents the considered opinion of the Government, but not its final decision. The proposals will be freely examined and discussed in Parliament and throughout the country. Discussions will be held with representatives of the medical profession, local authorities voluntary hospitals, pharmacists and so forth. In the light of the constructive criticisms thus obtained, legislation will be proposed later in the year. Copies of the White Paper are being sent to 50,000 doctors practicing in Great Britain, or serving in the armed forces, and their comments on the scheme are invited.

This paper is not to be confused with the White Paper on social insurance (arising out of the Beveridge Report), which is still in preparation. It does, however, aim at the fulfilment of Assumption B of the Beveridge Report — the assumption of comprehensive health and rehabilitation services for all as a basis for comprehensive social insurance.

### *Medical Facilities*

Complete free medical facilities, general and specialist, are to be easily available to all. These will include the following:

*General medical care.* General medical care will be supplied by a general practitioner for every man, woman and child. Free choice for both patient and doctor is to be preserved. As under the present National Health Insurance scheme, patients will be free to employ doctors privately, if they wish, and doctors will be free to have a private as well as a public practice. Patients who come into the scheme will be able to choose their own doctor. The object of the new scheme in this respect is to preserve the personal doctor-patient relation, while ensuring that efficient and specialised advice and treatment are available to all.

Within the scheme general practitioners will be free to work either, as now, in their own surgeries or in grouped practices, similar to present privately arranged partnerships, or in health centers. These centers, which are to be increased and developed to the fullest extent, would provide doctors with special medical facilities and equipment, laboratories, up-to-date premises, nursing and clinical assistance, and young assistant doctors, which at present they must provide for themselves. Doctors would work as individuals in their own consulting rooms in the centers, patients being free to choose their own doctor, who would visit them in their homes if necessary.

*All necessary drugs, medicines and all except the more expensive medical appliances.* The details of this section are to be worked out by pharmaceutical bodies in consultation with the Government.

*Full and improved hospital services.* There will be a co-ordinated hospital service over wider areas, so that each patient goes to the hospital where he will get the best possible specialised treatment.

The voluntary hospitals which, although an essential part of national medical services, are governed and operated independently, will be invited to take part in the national scheme under their own management, but under compulsion to observe the general conditions. In return they will receive certain service payments in accord with centrally determined scales, but less in amount than the actual cost of the services rendered. (If the voluntary hospitals are to be maintained they must continue to rely largely on their own resources and private benefaction.) Certain other payments will also be made to the hospitals from the Central Fund in respect of their help in the scheme, and it is suggested that the hospitals may wish to make one fund of these, from which allotments could be made to individual hospitals according to their need.

There will be no interference with the internal management of voluntary hospitals — no surrender of their independence or change in their status.

All hospitals will be visited and inspected by experts who will keep them in touch with the latest advances in medical science.

*Full specialist and consultant services.* These will be available through the patient's family doctor, at hospitals, at health centers or in the home. General practitioners will be able more freely to call in consultants and will have a closer connection with the work of the hospitals. Special steps are to be taken to increase the number of consultants and to spread them over a wider area. Regular scales of remuneration and conditions of service are suggested. Consultant services will be based on the hospitals, although group practices and health centers will also offer more specialised treatment than the average general practitioner can offer today.

*Maternity and child welfare services.* All the present institutional arrangements, in hospitals and maternity homes, for maternity cases will become simply one part of the reorganised hospital and consultant services under the Joint Authority. The present maternity and child-welfare clinics will continue to function under the responsible local authorities. Domiciliary midwives and health visitors will be associated with the services.

*School medical service.* Both the new Education Bill and the present White Paper envisage that the education authorities will retain the function of inspecting school children and encouraging necessary medical treatment. When the new health service is inaugurated, however, children as well as adults will look to it for medical treatment.

*Tuberculosis dispensaries, cancer diagnostic centers and mental clinics.* All these will be outpatient activities of the reformed hospital and consultant services under the Joint Authority.

*Full dental and ophthalmic service.* A full service of this type will be impossible for some years, since steps must be taken to increase the supply of dentists and oculists. Until then, children, young people and expectant and nursing mothers will receive priority.

*Home nursing service.* The object of this will be to ensure that those who need nursing attention in their homes will be able to obtain it without charge. Details of administration are being discussed. The scheme will probably be administered by county and county-borough councils.

### *Organization and Remuneration of General Practitioners*

There will be no compulsion on doctors to join the National Health Service, but it is expected that the great majority will do so, just as the great majority have joined in the present National Health Insurance scheme. Doctors who take on a public practice will be free to have a private practice also. The numbers of private patients will inevitably be reduced, however, as equally good treatment and care will be available free in the public service.

In order to ensure equality of conditions of public service throughout the country, it is proposed that the general practitioner service will, in the main, be centrally organised.

The Central Medical Board, appointed by the Minister of Health, will be responsible for much of the administration of the service and will act as "employer" of doctors who take part in the service. It is with the board that doctors will enter into contract. (Doctors in health cen-

ters will enter into a three-sided contract with the Central Medical Board and the local authority.)

As described above, doctors will be free to join the public service either in separate practices, in group-practices or in health centers. It is proposed that young doctors fresh to the service should start their work as apprentices to more experienced general practitioners.

The proposals of the White Paper as regards remuneration of doctors do not envisage a system under which all doctors engaged on public service would be paid by salary. It is suggested instead that, whereas doctors in health centers should be salaried workers in order to prevent any competition for patients, those in separate practices should normally be paid according to the number of public patients in their care — a capitation system similar to that now used under the National Health Insurance scheme. Doctors in grouped practices other than health centers will be able to choose which method they prefer. It is proposed that the maximum number of patients that any one doctor may care for should be regulated. A doctor having a private as well as a public practice will be allowed fewer public patients, and thus less public remuneration.

Although there will be no interference with doctors who wish to go on practicing where they are and to take part in the local public service, there will be regulation of the entry of doctors into new practices, in order to ensure reasonable distribution throughout the country. Doctors wishing to set up a new, or take over an existing, public practice will have to obtain the consent of the Central Medical Board. If the area is "over-doctored," permission may be refused. The Joint Authority will be responsible for the integration of general medical practice within the general area plan — including arrangements for the numbers and distribution of doctors and their liaison with hospital, specialist, clinic and other services in the area.

The sale of practices will clearly be affected by the regulation of doctors entering new practices. A doctor giving up his practice in an "over-doctored" area may find that the board will not permit his practice to be purchased. Again, practices within a health center will not be saleable. Thus a doctor who leaves a private practice for a health center will be exchanging a practice that he can sell for a practice that he will be debarred from selling.

To remedy these cases of hardship a scheme of compensation for practices that lose their value and a superannuation system for doctors in health centers will be organised. The whole question of the sale and purchase of public practices is to be discussed with the profession, particularly with a view to preventing the new public service from increasing the value of any individual practice.

*Administration*

Central responsibility to Parliament and the people will rest with the Minister of Health. Advising the Minister, but independent of him, there will be the Central Health Services Council, which will provide professional guidance on the technical aspects of health service. This would represent the main medical organisations, the hospitals, medical teaching, dentistry, pharmacy, nursing, midwifery and so forth.

In accordance with principles of decentralisation and with present practice, county councils and county-borough councils will be responsible for securing comprehensive and efficient clinics and general health services within their areas.

But in order that the most efficient specialised services may be available for all areas, it will be necessary for certain areas to co-operate with each other.

Areas able to provide complete and self-contained hospital and specialist organisation will be designated by the Minister of Health after consultation with local bodies. County councils and county-borough councils in these areas will form joint authorities to administer hospital, consultant and allied services. Each joint authority will have the responsibility of planning the whole of the area's medical services, although actual provision and management of certain local services will be the responsibility of the individual county councils that form the Joint Authority. Alongside each new authority there will be a local health-services council — a professional and expert consultative body.

Local operation of child-welfare services will be the responsibility of the local authorities.

There will also be the Central Medical Board which, unlike the Central Health Services Council, will have executive functions in the working of the general practitioner service.

*The Service in Scotland*

The scope and purpose of the National Health Service will be the same in Scotland as in England and Wales. The above proposals will apply generally to both countries, subject to a few administrative differences.

Central responsibility will rest with the Secretary of State for Scotland. There will be a separate Central Health Services Council and a separate Central Medical Board for Scotland.

As local government organization and geographical features are different, the local administrative structure cannot be identical. About 80 per cent of the population of Scotland is concentrated in 17 per cent of the total area. Over wide areas there is a very sparse population, and local government units there lack the resources of urbanized England and Wales.

The five natural hospital regions of the country — based on Glasgow, Edinburgh, Aberdeen, Dundee and Inverness — are too large to serve as administrative units. It is proposed that each of these areas should have a regional hospitals advisory council with consultative and advisory functions. The actual administration of the hospital and consultant services would be entrusted to joint hospital boards, to be set up for smaller areas within the regions. (Thus the advisory and executive functions of the joint authorities in England and Wales would be divided in Scotland between two bodies.)

Clinics and other services not closely allied to the hospital service will remain in the hands of the major health authorities, who will be required to combine where necessary for the efficiency of the health service.

Health centers will be directly provided and administered by the Secretary of State for Scotland instead of by the local authorities, as in England.

Instead of local health services councils there will be a local medical services committee for every joint board area. This will advise on the development of the general practitioner service and act as liaison between this and other parts of the National Health Service.

*Finance*

It is estimated that the total annual cost of the National Health Services will be about $592,000,000, compared with about $244,000,000 spent from public funds on the present health services.

The cost will be met both from central and local public funds. The extent to which these will be made up by contributions under a social insurance scheme remains to be considered in the forthcoming White Paper on social insurance.

The State itself will spend directly about $134,000,000 on the new general practitioner service, including payments to chemists and the whole cost of health centers in Scotland. It will also give a grant of 50 per cent to help county and county-borough authorities to meet the increase in the total cost of the health services. The grant will be adjusted to give more help to poor areas and less to rich. Every new service other than the hospital and consultant service (health centers, dental and ophthalmic services and home nursing) will be assisted by 50 per cent grants. Joint authorities will receive a grant of $400 a bed ($140 in mental and infectious disease hospitals) in aid of hospital and consultant services. A similar grant will be paid to voluntary hospitals.

*Conclusion*

In conclusion it should be observed that the National Health Service will not only aim at the abolition of ill-health but at the positive improvement of good health. Its fundamental object is best expressed in the introduction to the White Paper, where it is stated that the Government wishes to ensure for every man, woman and child "that what they get shall be the best medical and other facilities available; that their getting these shall not depend on whether they can pay for them or on any other factor irrelevant to the real need — the real need being to bring the country's full resources to bear on reducing ill-health and promoting good health in all its citizens."

## NOTE

The appointment of Dr. Alfred L. Johnson, professor of clinical dentistry, as administrative officer of the Harvard School of Dental Medicine and associate dean of Harvard Medical School, has recently been announced. The School of Dental Medicine on March 31 assumed responsibility for all dental education and research at Harvard University, succeeding the Harvard Dental School, the oldest university dental school in the United States, having been founded in 1867.

# CORRESPONDENCE

## A VISIT TO A TUBERCULOSIS SANATORIUM IN NORTHERN ICELAND

*To the Editor*: Five miles south of Akureyri, on the sharply rising land on the west side of the Ejyafjordur (Island Fiord), one can see the white walls of a three-story building of rather imposing size and pleasing appearance. A drive of easy grade from the main road soon brings one to the entrance of the large central building. The latter nestles against the hillside surrounded by smaller outlying structures, presenting the same white walls and clean-cut modern lines. This was the Kristnesi Tuberculosis Sanatorium, which I had been eager to visit ever since I had first viewed it shortly after my arrival in the northern part of Iceland. No doctors I had known had visited it, so I was convinced that if I was to learn a little of how the Icelandic Government takes care of its citizens with tuberculosis, I should do well to visit one of their sanatoriums, of which Iceland has two. I had read that tuberculosis in Iceland has been for many years one of the chief causes of death among the adult population. Besides, I had heard many extravagant rumors about the disease, such as the one asserting that almost everybody on the island is supposed to have had it (at one time or another) and that one can catch it very easily. For more reasons than one I was eager to find out some facts for myself.

A week before my visit I had been instructed by an Icelandic friend of mine just how to ask for the physician in charge. Diligently I memorized the phrase, which phonetically sounded much like this: "Git yerkt tal lath with Rafnar *Laeknir*?" Translated it meant, "May I speak with Dr. Rafnar?"

With these few words on the tip of my tongue, I set out one afternoon for the sanatorium. In a short time I arrived at the small courtyard in front of the main building. From almost every window facing in my direction many people stared at me; these were the patients, and apparently the sight of a uniform was unusual for them. Considering their prolonged confinement, I realized later that their curiosity was only natural. A simple doorway led into a long corridor where patients were lounging; there was no vestibule or lobby. A young man stood just inside the door, apparently directing other visitors to the various parts of the hospital. In the phrase I had remembered, I asked him if I might speak to Rafnar *Laeknir*.* The wording and accent must have been fairly correct, as he quickly nodded and turned to

*It is the custom in Iceland for most physicians to be addressed by their first name followed by *Laeknir* — hence, Rafnar *Laeknir*."

guide me to a large two-story concrete house across the courtyard. Rafnar's apartment occupied the second floor. I knocked on his door and even called out his name, but all was silent and it was evident that the doctor was not at home.

Returning to the hospital, I found the man who had given me my first directions. He soon located the other resident physician, Richard *Laeknir*, who cordially greeted me. Fortunately he could speak English well enough for us to understand each other. He said he had plenty of time to talk and to show me whatever he could, so I felt reassured that I would after all learn something about the sanatorium, in spite of the fact that I had not been able to locate Rafnar. It was not long before we were engaged in a lively conversation.

His office led off the long corridor, which I could now see was on the second floor. There were two rooms: in the outer one were a desk, three straight-backed chairs and a bookcase containing, for the most part, medical journals on tuberculosis, with German publications predominating. In the inner room was a fairly modern fluoroscope. I later understood that Richard *Laeknir* did much of the roentgenographic work of the hospital. His basic medical training had been obtained at the university in Reykjavik, which he attended for five and a half years. He then went to Denmark for instructions in obstetrics, as no course on that subject was given in Iceland. Shortly after this, his final examinations were finished and he received his doctor's degree. A year of internship followed in a Danish hospital, during which time he contracted pulmonary tuberculosis. Soon, however, he was back at work as resident at a tuberculosis sanatorium near Jutland. After two years there he returned to Iceland. About six years ago he accepted his present position as the junior resident physician in this sanatorium.

At this point Richard *Laeknir* asked me if I cared to be shown about the hospital, and I was quick to assent. We first made the rounds of the rooms, which faced south, as did the kitchen, dining room and the two large porches. The patients' beds were rarely more than two or three feet apart; no cubicles or screens between the beds were visible. The hospital was overcrowded, having twenty more patients than normally; the census was eighty. This overcrowding, I later learned, was not limited to Kristnesi; at Vifilsstadir, the first tuberculosis sanatorium to be established in Iceland (1911), there were one hundred and eighty patients in a building planned for ninety. As Richard *Laeknir* and I were making our visit all the patients were resting quietly in bed, for it was the early-afternoon rest period. Richard *Laeknir* then told me that the buildings at Kristnesi had been erected in 1927.

We next stepped out on the two large porches, one reserved for men, the other for women. These were unoccupied at the time, but many steel beds were stacked up against the back walls, on the north side of the verandas. When the weather is pleasant and it is not too cold or windy, certain selected patients are permitted to use the beds. The latter are provided with mattresses and either sacks lined with sheepskin with the wool turned in, eiderdown comforters or woolen blankets (an important Icelandic product). This form of therapy is given more for the value of fresh air than for the exposure to direct sunlight, since most of the cases are of the pulmonary type.

Back in the main building on the first floor, we passed through a spacious kitchen that appeared to be clean and well aired. Large windows on the south side admitted light to every part of the room. On the floor just above was a dining room in which a partition was being torn down. The sanatorium had just bought an excellent cinema projector equipped for sound, and more space was desired for the showing of American and British films. We next stopped in at one of the pantries; the eating utensils had been put away in a clean, orderly fashion, but Richard *Laeknir* demonstrated the large steam sterilizers in which they were placed, after being carefully washed. On the third floor we visited a small clinical laboratory where simple tests were carried out. Specimens of sputum (*kraki*) were examined on glass slides, using the Ziehl–Neelsen technic.

Returning to his office, we made ourselves comfortable in two of the straight-backed chairs and continued our talk. I asked him if he would kindly give me more details regarding the treatment of his patients; he said he still had plenty of time to spend with me and would be only too glad to tell me all he could.

Patients are admitted to the two tuberculosis sanatoriums in two ways: one, directly from the patient's own physician; the other, through one of several state-supervised tuberculosis stations, which are scattered throughout the island. On the patient's discharge from either of the sanatoriums, a brief summary of the clinical record is forwarded to the tuberculosis officer in Reykjavik, who is responsible for its incorporation in the public-health records.

At Kristnesi any patient who has a fever must stay in bed at all times. No reclining chairs are used, but patients may be propped up in bed with pillows if this makes them feel more comfortable. For those who are afebrile and whose disease is evidently nonprogressive, a graduated scale of exercise is arranged. At first, they are allowed up between noon and 1 p.m. for several days; if they continue to remain afebrile and symptomless, the hours of being up are gradually increased over a period of weeks until the patients are up the whole day, — 8 a.m. to 9 p.m., — with the exception of the rest periods, during which they are supposed to sleep.

A patient's schedule for the day ran fairly close to this:

| | |
|---|---|
| 7:00 a.m. | Arise |
| 8:00 a.m. | Breakfast (*Morgennmatur*) |
| 10:30 a.m. to 11:30 a.m. | Rest period |
| 12:00 noon | Dinner (*Hadegismatur*) |
| 2:00 p.m. to 3:30 p.m. | Rest period |
| 3:30 p.m. | Coffee, cocoa or milk with cakes and bread |
| 5:30 p.m. to 6:30 p.m. | Rest period |
| 7:00 p.m. | Supper (*Kvoldmatur*) |
| 9:15 p.m. | Lights out |
| 8:00 p.m. to 10:00 p.m. | Cinema (usually held once a week) |

The patient who continues to improve under this program may in time take short walks once to three times a day for periods of fifteen minutes increasing to one hour, if he tolerates outdoor weather. Pneumothorax treatments are given by either of the two resident physicians. This form of therapy is attempted in all the pulmonary cases, and when it fails to produce the desired result, more complicated procedures are resorted to (pneumolyses, phrenicorrhexes, rib resections and so forth). About six operations of this type are performed each year at the Akureyri Hospital (*Sjukrahus Akureyrar*) by its chief surgeon, Gutmunder Karl *Laeknir* (Pétursson), who at the time of my visit was attending a meeting of the American College of Surgeons in Philadelphia. Patients who for one reason or another are not able to receive this care are required to adopt longer rest periods and a more graduated treatment schedule.

Patients with evident tuberculous involvement of the pleura without demonstrable pulmonary infiltration of the lymph nodes or of the skin are encouraged to expose themselves to the direct rays of the sun or to sun lamps. Kristnesi has one of the mercury-vapor type. Exposure is carefully regulated. Treatments at first are brief; later the exposure periods are increased to suit the toleration of the patient.

At night and during rest periods, the windows of the patients' rooms, which are large even by our standards, are kept open as widely as possible. Frequently, however, they have to be kept closed owing to the high winds so common in this region. Draughts are sedulously avoided to minimize air-borne spread of the tubercle bacilli. The main building had ventilating conduits, but as a result of a roof fire the previous year, these had had to be blocked up. It is realized that the present ventilating system is unsatisfactory, but funds for its improvement are lacking.

The patients are encouraged to keep their minds occupied with varied interests. Although no formal occupational therapy work is done at the sanatorium, ambulatory patients do a considerable amount of weaving on small, light wooden frames that can be held in the lap; knitting and embroidery are popular with the women. The value of this type of therapy is being increasingly appreciated in the sanatoriums in Iceland, and plans have already been arranged at Kristnesi for the construction of a separate building for looms, drawing boards, woodworking benches and so forth. Richard *Laeknir* thinks that work patients can do with their hands or feet is helpful for nonpsychotic depressive moods; in addition, he believes that the patient may develop more resistance while thus occupied, that this work makes the time pass more quickly and finally that it is well to have those who are going home to more or less heavy household and farm work prepared to use their bodies, particularly their hands and feet.

The hospital stay varies from two months to ten years. Since almost all the patients are unable to pay the full cost

of their treatment, their expenses are partially or wholly defrayed by the State. Approximately 70 per cent of the patients admitted to Kristnesi or the other tuberculosis sanatorium are discharged healed or practically so. Richard *Laeknir* did not have figures available to show what the exact results were.

The sanatorium provides training for two student nurses at one time; each spends six months there as part of her nursing course, most of which is taken at the University Hospital (*Landspitalinn*) in Reykjavik. The latter, with 200 beds, is the largest general hospital in Iceland.

By now I had been almost two hours on my visit, but my host urged me to stop in at his apartment before going back to camp, and I agreed. It was just across the road down the west slope of the fiord — a one-story, white cement structure. As we entered through a small wooden gate, there were four or five young children scampering about the yard. We passed through a doorway into a narrow hall where toys and rubber overshoes were scattered about. There were two apartments, one occupied by Richard *Laeknir*, the other by the superintendent of the sanatorium. The former had just four rooms — a sitting room, bedroom, bathroom and kitchen — in which he, his wife and their one-year-old son, lived. The sitting room was small, yet comfortably furnished; mulberry-colored draperies framed the unusually large and pleasant windows; two striking oil paintings by Kjarval, Iceland's best-known contemporary artist, were tastefully hung on the wall opposite me; both depicted wide stretches of wild, forbidding, lava-strewn land. These paintings had been a gift in which Richard *Laeknir* evidently took pride. We sat down in two armchairs, near several brightly polished brass ornaments, including a huge, flat brass tray with small ash receptacles on it.

A few minutes after our arrival a buxom, smiling young woman entered the room and was introduced to me by Richard *Laeknir* as his wife. She spoke no English, but her cordial expression spoke for her and I knew right away that I was welcomed. She soon withdrew from the room, bowing slightly. From the sounds I shortly began to hear in the adjoining rooms, I knew she was preparing some refreshments. While she was gone, Richard *Laeknir* and I continued our conversation.

Up to 1930 Iceland had had high morbidity and mortality rates in tuberculosis. Both, fortunately, have dropped since then. The highest accurately recorded death rate from all forms of the disease was in 1920, when it was 210 per 100,000. In 1918 it had been 200. In 1929 and in 1932 it was still at this figure, dropping in 1937 to 130, and in 1941 to 80. At present the death rate is 100 per 100,000; since the population now totals 120,000, approximately 120 died last year from this disease.

Tuberculosis is being discovered and treated earlier than it was twenty years ago. Still, many cases are far advanced when the patients first arrive at the sanatoriums. This past year there seems to have been an increase in the incidence of the pulmonary type of the disease, chiefly in adolescents, particularly girls. The overcrowding in some of the larger cities, like Reykjavik, and the increase of measles this year are considered to be possible contributing factors. Also there still remain people who, though obviously ill, procrastinate about seeing a physician. As yet there is no law forcing one to go to a sanatorium unless the person has active (contagious) tuberculosis and lives in proximity to young children and adolescents. Chest roentgenograms are being increasingly utilized on the outside, even in the country districts; in some of the latter, especially where the local morbidity rate of tuberculosis is high, all except the very young have had them. Contacts are always skin-tested; usually the von Pirquet method is first employed; if this test proves positive, the Mantoux is used; if the latter is also positive and the patient is young, chest films are always taken. All patients at Kristnesi are skin-tested.

Tuberculosis in cattle is rare. Bovine-type bacilli are infrequently found, and there is little of the childhood form of the disease. Although most of the cows are not tuberculin-tested, the only milk that is rendered pathogen-free (stassinized — a Swedish method) is available solely in Reykjavik and Akureyri. A dairy farm outside Reykjavik supplies milk from a herd of tuberculin-tested cows for the use of young children.

All autopsies in Iceland are performed, with rare exceptions, by a specially appointed medical officer in Reykjavik. According to this plan, no postmortem examinations may be carried out by either of the physicians at Kristnesi. An autopsy in a medicolegal case may be performed in any locality by a properly authorized physician. In the ordinary situation the majority of people, unfortunately, refuse to give their permission for an autopsy. When a patient dies at the Kristnesi sanatorium and permission has been obtained to perform an autopsy, the body has to be preserved in some manner, shipped to Reykjavik by boat, a voyage of two to three days, and finally be examined by someone unknown to the family. Under these conditions it is readily seen why not many permissions for autopsy are given. As yet no law exists that allows the performance of an autopsy without this permission.

Toward the conclusion of our talk, Richard *Laeknir* said a few words about two other diseases that in years past were frequent throughout this land — smallpox and leprosy. At present smallpox is nonexistent, chiefly owing, without doubt, to universal vaccination, which long ago was adopted in this country. All persons are vaccinated in their first year, in the fourteenth and at other times as deemed advisable in the individual case. Leprosy was common in the eighteenth century, when the disease, then rife throughout the world, spread to Iceland via (so it is thought) the Baltic States and Norway. Leprosariums were soon established: — the first at Laugarnes pronounced phonetically "Lerr-gar-ness"), just outside Reykjavik. (Laugarnes means "warm fountain near the peninsula"); the second at Kópavaegur, about halfway between Reykjavik and Hafnarfjordur. At present there are about 20 cases of leprosy in Iceland.

Distribution of medical care was only sketchily discussed. In contrast to the present situation in the Unites States, it is largely under the direction of the State. Iceland is divided into fifty-two districts, with a physician assigned to each one. For assuming care of all indigents in his district, this man is paid a salary by the State, varying before the inflation (1941-1944) from 3000 to 4000 *kr.* (prior to 1941 a *krona* was worth 15 cents). The higher salary is obtained in the more sparsely populated districts. The physician is allowed to have private patients, but the latter are comparatively rare, so that his chief source of income is the salary paid him by the State. The position of being a district physician is now not much desired by the men just entering practice. Instead, the majority are eager to take up a specialty in Reykjavik. This poses a serious problem in the distribution of medical care in the near future. The threat of an actual oversupply of physicians in Iceland presents another problem, made more pressing with each passing year. The School of Medicine at the University of Reykjavik has been overcrowded for the past few years and, so far as Richard *Laeknir* knew, there has been no enforced limitation on the number of entering medical students; there has been solely the scholastic requirement to fill. The School of Medicine at present has a total of about sixty students, with about ten to each class. It was his opinion that three or four doctors each year would be sufficient for the needs of Iceland.

By that time his wife had returned with delicious coffee and several kinds of cakes and cookies and had set them out most attractively on a card table on the other side of the room. Richard *Laeknir* and I sat down on two small chairs so that we faced each other. I was surprised that his wife did not sit down with us and also partake of the refreshments, which I wish to repeat were delicious. Later I learned that it is the usual custom for the wife to wait on her husband when he is entertaining a stranger, and not to join in either the conversation or the refreshments.

My visit over, I took my leave, thanking them both as best I could for the truly delightful and interesting time I had had. My driver had just driven up to the outside gate in the ambulance, and soon I was well along the narrow road back to camp.

CAPTAIN T. DENNIE PRATT, M.C., A.U.S.

Iceland

## NOTICES

### SUFFOLK DISTRICT MEDICAL SOCIETY

The annual meeting of the Suffolk District Medical Society will take place on Wednesday April 26, at 7:30 p.m., at the Hotel Puritan, 390 Commonwealth Avenue, Boston. Dinner will be served in the Crystal Room. Dr. Frank H.

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NOTICES (*Continued from page 476*)

Lahey will speak on the subject, "Medicine Today at Home and in the Mid Pacific."

There will be a business meeting at 7 p.m. for the election of officers.

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## SOCIETY MEETINGS AND CONFERENCES

### Calendar of Boston District for the Week Beginning Thursday, April 20

Thursday, April 20
*9:00–10:00 a.m. Medical clinic. Dr. S. J. Thannhauser. Joseph H. Pratt Diagnostic Hospital.
6:00 p.m. New England Pathological Society, Harvard Club, Boston.

Friday, April 21
*9:00–10:00 a.m. Peritoneoscopy. Dr. Edward B. Benedict. Joseph H. Pratt Diagnostic Hospital.

Saturday, April 22
*10:00–11:30 a.m. Medical staff rounds. Peter Bent Brigham Hospital.

Monday, April 24
Massachusetts Safety Conference on War Production and Civilian Defense. Hotel Statler, Boston.
*12:15–1:15 p.m. Clinicopathological conference. Peter Bent Brigham Hospital.

Tuesday, April 25
Massachusetts Safety Conference on War Production and Civilian Defense. Hotel Statler, Boston.
*9:00–10:00 a.m. Medical clinic. Dr. S. J. Thannhauser. Joseph H. Pratt Diagnostic Hospital.
*12:15–1:15 p.m. Clinicoroentgenological conference. Peter Bent Brigham Hospital.

Wednesday, April 26
*9:00–10:00 a.m. Cardiac Clinic. Dr. Heinz Magendantz. Joseph H. Pratt Diagnostic Hospital.
*12:00 m. Clinicopathological conference. Children's Hospital.
7:00 p.m. Suffolk District Medical Society. Hotel Puritan, 390 Commonwealth Avenue, Boston.

*Open to the medical profession.

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April 13. The Use and Misuse of Bacterial Chemotherapy. Dr. Charles A. Janeway. Pentucket Association of Physicians. 8:30 p.m. Haverhill.
April 18. New England Ophthalmological Society. Page 443, issue of April 6.
April 29. Long Island College of Medicine. Page ix, issue of March 30.
May 3. New England Society of Physical Medicine. 8:00 p.m. Hotel Kenmore, Boston.
May 5. Massachusetts Central Health Council. Page 443, issue of April 6.
May 8-14. War Conference on Industrial Medicine, Hygiene and Nursing. Page x, issue of March 23.
May 10. New England Oto-Laryngological Society. Page 443, issue of April 6.
May 23 and 24. Massachusetts Medical Society. Annual meeting. Hotel Statler, Boston.
June 7–13. American Board of Obstetrics and Gynecology. Page x, issue of March 23.
June 12–16. American Medical Association. Page 798, issue of November 18.
June 12–16. American Physicians' Art Association. Page x, issue of March 2.
October 3–5. American Public Health Association. Page ix, issue of March 30.

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### District Medical Societies

Suffolk

May 4. Censors' Meeting. Page xiii, issue of February 10.

Worcester

May 10. Annual meeting.


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